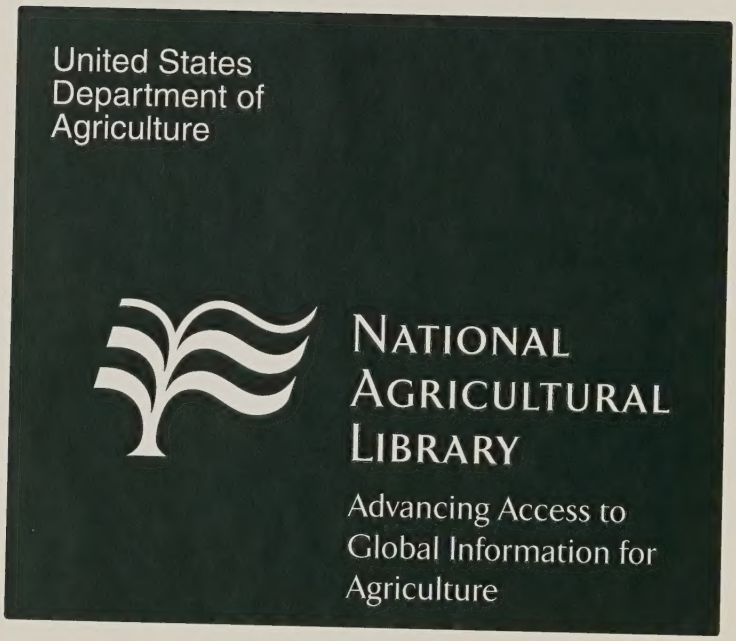
John W. Barry

PROCEEDINGS:

WORKSHOP ON AERIAL APPLICATION OF INSECTICIDES AGAINST FOREST DEFOLIATORS

COLUMBUS, OHIO

APRIL 5-6, 1977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P R O C E E D I N G S

WORKSHOP ON AERIAL APPLICATION OF INSECTICIDES AGAINST FOREST DEFOLIATORS

April 5 & 6, 1977

Rodeway Inn
900 East Dublin Granville Road
Columbus, Ohio

Sponsored By:

USDA-Forest Service
Northeastern Area, State and Private Forestry
Forest Insect and Disease Management
Upper Darby, Pennsylvania 19082

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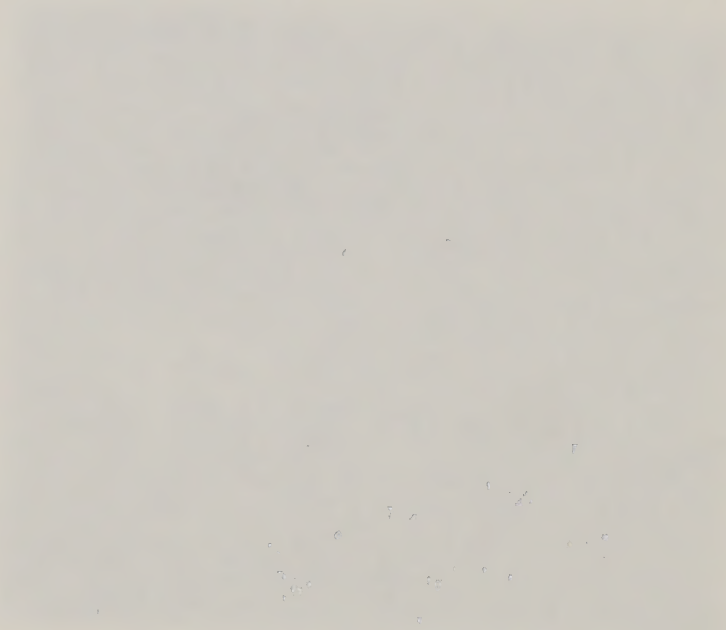

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WELCOME

AERIAL APPLICATORS WORKSHOP

by

Ernest J. Gebhart, Chief
Division of Forestry
Ohio Department of Natural Resources
Columbus, Ohio 43224

Welcome to Ohio.....The Buckeye State, the home of Ohio State and Woody Hayes and the home of 11 million people of assorted interests ranging from agriculture to heavy industry. The six and one quarter million acres of forest land in Ohio are a significant part of Ohio's agriculture base. Ohio has been a leader in the production of fine hardwoods, especially black walnut. Recently Ohio made history when a single sale of 18 walnut trees brought $80,000. This in itself is spectacular but one particular tree in that sale was said to be the finest walnut cut in modern times. It reached 57 feet to the first limb and scaled out to 2,300 board feet of architectural grade veneer.....enough to cover two and three quarter acres. The buyer valued this tree at $30,000.

This example, along with Ohio's high grade oaks, maple, tuliptree, and numerous other excellent hardwoods and conifers should convey the idea that we value our timber stands and make an effort to protect them from the ravages of wildfire, insects and disease.

The Ohio Division of Forestry assumes a major role in the protection of these forest lands. Since 94% of Ohio's six and one half million acres of forest is in private ownership, the Cooperative Forest Management Program and the Cooperative Fire Program are geared to serve them. We have 21 service foresters working throughout the state who provide assistance in timber management including gathering information on insect and disease activity. A forest insect and disease specialist on my staff, Mr. Larry Ehlers, coordinates the reports of the service foresters, provides some service to the landowners and refers outbreaks or buildups to state or federal agencies dealing with pest control.

Rangers and crews on the 18 state forests provide fire control service to six million acres of woodland in eastern and southern Ohio. They also deal with the assorted insects and diseases that attack the 170,000 acres of state forest land.

A major objective of the division is to keep fire and pest losses in Ohio timber at a minimum. We think we are doing a good job in this respect in fire prevention and control but do not have that good a grip on insect and disease problems. We have had oak wilt, Dutch elm disease, anthracnose, pine shoot moth, hemlock looper, ips, pine sawfly, and many more and now threats of gypsy moth and southern pine beetle.

For this reason, we are particularly pleased to have your meeting here in Ohio where we can benefit from your knowledge and experience in minimizing damage from these pests.

Several division employees, in addition to Mr. Ehlers, are spending these two days with you. If there is any way we can make your stay more comfortable, please let me know.

Thank you and best wishes for a fruitful and productive meeting.

IMPORTANCE OF QUALITY AERIAL APPLICATION OF INSECTICIDES

by

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State & Private Forestry
Upper Darby, Pennsylvania 19082

Good morning! It is good to see so many persons take an active interest in this important area of work for forest entomologists and resource managers. The subject I am speaking on happens to be one which I have taken more than just a passing interest in during the past ten years. It's a pleasure for me to be here.

Quality application of pesticides is a goal which all of us here must work hard to achieve. This is true whether we are applying an insecticide, herbicide, fungicide, etc.; whether it is sprayed from aircraft or ground rigs; whether it is seeded or injected; and whether it is highly toxic, broad spectrum, long lasting-or-low toxicity, host specific, and short residual. Quality application is what you must expect of yourself; the resource manager expects it of you; and the public expects it (and in more and more cases is demanding quality application of pesticides).

What is quality aerial application? It is achieving planned deposits of spray throughout the target area, and in such a way that it can come in contact with the target pest within the prescribed time interval; and avoiding spray deposit in non-target areas.

Quality aerial application of insecticides is one of the many factors that must be taken into consideration when suppressing insect infestations. Several of these factors will be discussed at this workshop and are listed as major subject items on the agenda. There are many others such as those involving the suppression decision, pre and post spray surveys, and monitoring. But after all these other factors are discussed and cussed and

finally carried out with 100 percent efficiency and accuracy, the project effectiveness hinges on one unescapable factor - application quality. With today's conventional insecticides, you must have the insect and insecticide come in contact or you don't get expected control, regardless of how "good" the insecticide is. Many years ago when DDT was "the" pesticide for forest defoliators, it was said that all you had to do was go into the woods and yell "DDT" and you would get 100 percent kill!

DDT is good, but not that good. It is effective only when the pest and chemical come together, regardless of what has been said.

Effectiveness....Effective control can only be reached through quality application.

Pesticide technology has advanced remarkably. For some pests we have a wide variety of insecticides on the shelf, available for use. They range from being essentially non-selective to species specific. They range from having long residuals to essentially non-residual. Most insecticides used in aerial spray are highly toxic to only a narrow band of pests. While this variety is needed, there continues to be the shift towards low residual, host specific, highly toxic insecticides.

In more and more instances we find ourselves using pesticides that require specialized application equipment and precision application. Dosage rates of less than .1 pounds of active ingredient per acre sound ridiculous. But for certain pesticides against certain pests these low dosages work when applied as planned. Some pesticides lose their toxicity within hours after spraying, others are only effective against certain larval instars, but they work when applied as planned. A common thread among all this new technology is that the cost of materials and aircraft on a per unit basis continues to rise. We simply can't afford inefficiencies, either technical or economic.

Efficiency....efficient use of highly developed insecticides, and efficient use of available funds can only be reached through quality application.

Whether the insecticide is species specific or not we don't want it to go outside the target area. The primary reason for this is to avoid introduction of a pesticide into an environment where it serves absolutely no purpose, and is in every sense of the word an unnecessary pollutant. Past carelessness and

arrogance, in this regard, put a black hat squarely on heads of pest control people and incidently, there were a lot of square-headed Pest Control people. Try as we may, we can't get rid of that hat. But this we can do -- never use pesticides outside of the prescribed manner to meet the specific objectives of our control projects. At the same time, we should not be reticent in telling the public what we are doing, how, and why.

Spraying pesticides is a controversial matter. Let's be sure we know what we are doing, and be ready to face the issues and vigorously defend our position.

Environmental quality awareness....Environmental quality of non-target areas can be maintained through quality application. Effectiveness, efficiency, and the environment - these three big E's, then, spell the importance of quality aerial application of insecticides.

Before concluding, I would like to return to the definition of quality aerial application. I said it is achieving planned deposits of spray throughout the target area, and in such a way that it can come in contact with the target pest within the prescribed time interval, and avoiding spray deposit in non-target areas.

I would like to dwell on the word "achieving". How do you know if you achieved your suppression project objectives? How do you know your application was of the quality it should have been? The answer is simple; did you meet the objectives or not? But getting the answer is tough and costly. In fairness to ourselves and the land managers we serve, and the public, we need to give some straight arrow answers on whether objectives have been met.

I don't think we can judge the quality of a suppression project unless we can account for spray deposit. We must be in position to only give credit where credit is due. We can no longer be complacent regarding data collection procedures and efforts in suppression programs. We must be able to quantify the net effects that occur in the forest ecosystem as a result of treatment. We must do this to correctly guide and provide a base for the pest management scientists who will follow us. We must do it to have the best, environmentally safest, and most cost effective tools available to us now and in years to come.

Thank you.

TYPES OF AIRCRAFT AND SPRAY SYSTEMS

by

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FI&DM Methods Application Group
Davis, California 95616

INTRODUCTION

Spray application is both an art and a science requiring the skill of the applicator and technology developed by the physicist, engineer, and biologist.

Environmental, social and economic concerns, coupled with the increasing need to protect resources and the harvest, place great responsibility upon the pesticide producer, applicator, and agricultural and forest industries.

Existing spray equipment and aircraft technology must be used in the most efficient manner possible limited only by the inventory of registered pesticides and available spray equipment.

Both the applicator and the customer, whether he be a farmer or forest resource manager, has a responsibility in understanding the limitations, capabilities, and hazards associated with spray equipment. Although it is beyond the scope of this paper to discuss all these elements, it should suffice to say that both should have an understanding of these elements and apply the pesticide consistent with the registration label instructions, following recognized safety procedures and State and local regulations.

BASIC COMPONENTS OF SPRAY SYSTEMS[1/]

Spray systems usually consist of the following components:

Tank
Dump system
Pump
Bypass valve/regulator
Shut-off valve
Nozzles and spray tips
Diaphragm check valve strainer
Pressure gauge
Spray boom
Strainer
Diaphragm check valve

Older aircraft such as the Stearman and other bi-planes will have a variety of systems. The new generation of agricultural aircraft such as the Cessna Ag series and Grumman Ag Cat usually come equipped with standard spray equipment installed by the aircraft manufacturer.

Tank

The spray tank confines the spray material inside the aircraft; it should have adequate filler port, vent to the outside of aircraft, and a sight gauge to monitor the level of material in the tank. A recirculation system is optional. Spray tanks are usually lightweight, constructed of a lightweight noncorrosive material. The size and capacity of the tank is determined by the size and weight limitations of the aircraft. Altitude and air density (density altitude) can change the actual gallonage the aircraft can carry at a given time. The density altitude is greater in the cool, early morning hours, thus, the aircraft can carry a given weight. As the day progresses and the temperature increases, the density of the air decreases and the weight or gallons the aircraft can carry must also decrease. Linings of spray tanks have a tendency to deteriorate in time or to collect debris. Tanks must be kept in a clean, serviceable condition.

1/ Sources of this information are:

a. Presentation by Tony Jasumback, MEDC engineer, at FI&DM-MAG course on calibration and characterization of spray aircraft held at Davis, California, May 1976.
b. Potts, S. F., 1958. Concentrated Spray Equipment and Application Methods. Dorland Books, pp. 598.
c. Personal communications with Gene Francioni, Medlock Dusters, Davis, California.

Dump System

The dump valve is provided so the pilot can dump the contents of the tank in an emergency. According to FAA requirements, the dump system must be capable of dispensing one half the load in 45 seconds; most spray aircraft dump systems exceed this capability. The mechanism to activate the dump should be easily accessible to the pilot. It is important to check this system to insure that it is in good operating order.

Pump

A pump is used to transfer the insecticide from the tank to the boom and out the spray tips at the desired pressure. Generally, centrifugal pumps are used and can be driven by a gas engine or hydraulically on the bigger aircraft. Fan-driven pumps are used on some of the smaller agricultural aircraft which must fly at a constant speed to insure a constant flow. Pumps on small helicopters operate through a clutch to the helicopter engine. Centrifugal pumps can operate at rated rpm and zero flow without damage which actually happens when the spray is turned off. The manufacturer provides curves of flow as a function of rpm.

Generally, centrifugal pumps are characterized by low pressure (less than 100 psig) and high flow rates (depending on size). The pump selected should have the capacity at the desired pressure.

Bypass Valve/Regulator

The bypass valve is used to regulate the boom pressure by bypassing that volume of material not needed at the boom, back into the tank. The bypass valve allows a large flow rate pump to be used at small flow rates. The material bypassed can be used to provide agitating within a tank.

Shut-off Valve (Boom on-off valve) (Boom valve)

This is used to allow or stop the flow of material to the boom. It should be located on the outlet side of the pump (never on the inlet side) with controls located for easy access to the pilot.

Pressure Gauge

The pressure gauge indicates the pressure of the insecticide in the boom which controls the flow rate through the nozzles. As the flow rate through the spray tip is dependent on pressure, considerable error in flow rate during initial calibration can be caused by gauge error. Therefore, the gauge should be checked or replaced frequently.

The pressure gauge pickup or port should be located downstream of the boom valve and the inline strainer in a relative straight section of pipe at least 10 pipe diameters from any obstructions. The gauge itself should be located where the pilot can readily observe it to insure boom pressure is being maintained at all times, and to indicate problems or when the tank is empty. Gauge accuracy is very important and it must be emphasized that it must be checked frequently.

Spray Boom

The boom is used to distribute the spray media from the pump to the nozzles, and provide support for the nozzles. There are many sizes and shapes of booms; some round and others streamlined (airfoil) shaped. The airfoil shape will reduce drag at the higher aircraft speeds compared to a round boom. The boom should be large enough to handle the desired flow rate with minimum pressure drop.

There seems to be no standard as to boom location; on fixed-wing aircraft they are found located above the wing, below the wing, and behind the trailing edge.

Also, the boom and nozzles should be located such that impingement on the fuselage and tail assembly is minimized. Otherwise, spray collects on these surfaces and as it builds up it is blown off in larger drops than those produced by the nozzles themselves, thus complicating the droplet spectrum if a narrow one is desirable, and wasting spray volume. Nozzles should not be placed at the wing tip or behind engines due to vortices which place great stress upon the spray drops resulting in adverse affects. As a rule of thumb, avoid placing nozzles on the area which represents the last 25% of the wing or rotor length.

Strainer

Normally an inline strainer is located in the system between the pump and boom to filter out large particles and foreign material that might clog the nozzles orifices, resulting in considerable reduction in the flow rate and consequently, the application rate.

A variety of seven sizes are available for these strainers ranging from 16 to 200 mesh. The strainers should be checked frequently. Strainers will collect foreign material and become clogged, restricting flow, again reducing the flow rate and consequently, the application rate. The recommended practice is to check and clean the strainer before and after each operating day. More frequent cleaning, however, may be necessary.

For most spray tips the manufacturer measures the flow rate through the orifice at various pressures using water. Flow rates of other liquids can be calculated very accurately if the specific gravity of the spray solution is known.

The actual flow rate through a spray tip is affected more by the specific gravity (weight relative to water) of the solution than by the viscosity. The tip could be considered an infinitesimal length of pipe as far as viscosity is concerned, and thus, it is negligible.

The flow rate correction factor for materials other than water is determined by the following equation:

Factor = 1 ÷ sp. gr., which should be multiplied by the flow rate for water.

SPRAY AIRCRAFT

Helicopters and fixed-wing aircraft of all sizes and descriptions have been used for forest spraying. Following is a partial list of these aircraft and their respective swath width. Note that these swath widths are to be used as a guideline only. Actual operating swath widths must be checked in the field by following procedures outlined in "Field Manual for Characterizing Spray from Small Aircraft" 2/.

2/ The reader may obtain information on spray aircraft characterization by reading the following publications:

a. Barry, John W., George P. Markin, and Robert B. Ekblad. 1978. Handbook-Sampling and Assessing Deposition of Insecticide Sprays Released Over Forests. USDA Forest Service, Forest Insect and Disease Management, Methods Application Group, Davis, CA 95616 (In press).

b. Dumbauld, R. K., and J. E. Rafferty. 1977. Field Manual for Characterizing Spray from Small Aircraft. Sponsored by USFS/Forest Insect and Disease Management and USFS/Missoula Equipment Development Center.

AIRCRAFT	SWATH WIDTH (FEET)
Boeing B-17	450 - 600
Curtiss C-46	450 - 600
Douglas C-47 or DC-3	375 - 500
Douglas DC-4 or DC-6	490 - 600
Douglas DC-7	600 - 750
Lockheed Constellation	575 - 750
Lockheed Lodestar, PV-1 or PV-2	375 - 500
Martin 404	450 - 600
Convair 240	450 - 600
Aero Commander	130 - 175
Beech C-45 or AT-11	130 - 175
Grumman TBM	225 - 300
Piper Aztec	130 - 175
Cessna AgCarryall & Pickup	95 - 125
Cessna AgTruck & AgWagons	95 - 125
Commander Thrust & New Air Tractor (Snow)	115 - 150
Commander Quail	95 - 125
Commander Sparrow	75 - 100
Grumman AgCats (400-600 hp)	95 - 125
Grumman AgCats (200-300 hp)	75 - 100
North American AT-6	115 - 150
Piper Apache (150-180 hp)	95 - 125
Piper Apache (235 hp)	115 - 150
Piper Brave	95 - 125
Piper Pawnee (230-260 hp)	75 - 100
Stearman (450-600 hp)	95 - 125
Weatherly	95 - 125
Collair (150-180 hp)	50 - 75
Piper Pawnee (150-180 hp)	50 - 75
Piper PA-18	50 - 75
Bell 212	150 - 200
Bell 206	125 - 150
Bell 205-A	150 - 200
Bell 47	60 - 90
Hiller 12-E	60 - 90
Hughes 500 C and D	50 - 75
Sikorsky S-55	150 - 200
Alouette III 316B	150 - 200 3/
Alouette II 318C	125 - 175 3/
Lama 315B	125 - 175 3/
Boeing-Vertol 107	220 - 315

3/ Swath widths for the Lama and Alouette are estimates as no field data on swath widths exist at this time.

Swath widths, payload, and maneuverability are three of the main considerations in selecting spray aircraft. The swath width is a function of the release height, gross weight of the aircraft, and wing or rotor length. Other factors which can significantly affect the swath width are type, size, orientation and positioning of spray nozzles, physical properties of the spray formulation and aircraft speed. Swath widths are usually expressed in terms of a range. To select the proper swath width for a particular application, one should establish the spray deposit criteria and check the swath by flying over a set of spray deposit cards following procedures presented below.

Helicopters are used almost exclusively in forest spraying in the mountainous terrain of the western United States, while both helicopter and fixed-wing aircraft of all sizes are used in the East. There are advantages and disadvantages to both helicopter and fixed-wing aircraft relative to turn-around time, maneuverability, and spray patterns.

SELECTION AND PREPARATION OF HELICOPTER LANDING SITES

By

Robert L. Bustamente, Forester
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Nicolet National Forest
Eagle River, Wisconsin 54521

The objective of this 30 minute talk is two-fold; to acquaint you with the general requirements for the preparation and management of the landing sites, and two, to help you intelligently gather the necessary data to complete the contract specifications concerning landing sites on your specific job.

The reason you need to know so much about the landing area is because a contractor bids by the acre - before he submits any bid he has to figure his turn around time, i.e., ferry time. Turn around time is greatly affected by the distance between the landing area and the job. You are going to have to locate the landing area before the contract can be advertised. (Average time to prepare and advertise contract - 90 days).

You won't necessarily be responsible for designing or managing the landing area, but you should know the requirements needed to meet the National and the Regional standards as directed by the Chief and the Regional Aviation Manager.

R-9 supplement to the FSM states that a R-9 approved Class I Helicopter Aviation Service Manager (Helicopter Foreman) shall be present at each helicopter landing site during operation of any helicopter for any purpose. However, State projects are not required to have an R-9 approved Air Service Manager.

As of January 1978 there were only 4 Class I's in R-9. (This is a change for the 14 Class I's managers recognized in R-9 at the time of our meeting.)

The following is a list of some of the manager's responsibilities:

1. He must inspect the pilot for qualifications and currency.
2. Inspect the aircraft.
3. Make out the time reports.
4. Make out flight manifests and load calculations.
5. Supervise fueling operations.
6. Manage the heliport in accordance with all safety regulations.
7. Act as ground guide for pilot.
8. Secure and provide all necessary ground facilities, supplies and services for base.
9. Construct helipads in accordance with rigid specifications.
10. Conduct flight following.

All that and more - no one has yet mentioned the requirements concerning insecticide operations. Although you may not be required to have a Class I Air Service Manager, please feel free to seek one's advice or assistance.

The attached drawing contains many critical items. We'll discuss them at length. The drawing of the minimum specifications is from FSM 5726.

Other important considerations include:

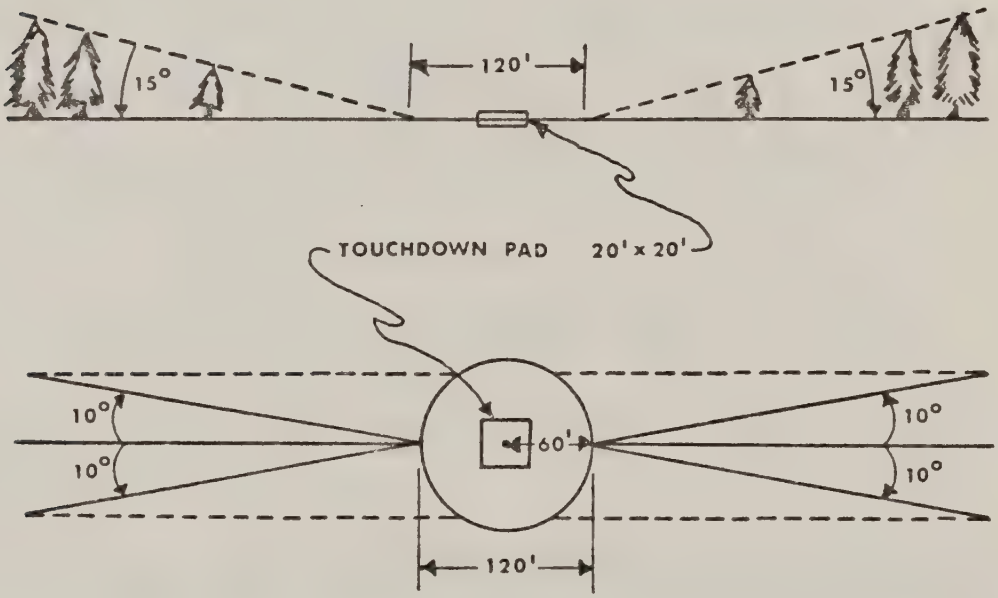
1. Using common sense concerning safety.
2. Considering the prevailing wind.
3. Providing a dust free landing surface, for example, use parking lot or water to keep dust down.
4. Locating the site so it is accessible by road. This is very important due to the sophisticated fueling and pesticide mixing machinery needed today.
5. Staying clear of populated areas and water surfaces. This is more than just being courteous, many pesticides require stringent precautions to protect both people and water surfaces.

6. Level area (may use 2x4 to elevate boom). The Microfoil boom is very sensitive and located at skid height.

7. As close to project as possible (try for a 2 minute or less turn around time).

TITLE 5700 - AVIATION MANAGEMENT

Helicopter Landing Areas. Helicopter landing areas will be constructed in accordance with the following specifications:



- - - - - - Clearance Area - *

All Helicopter Landing Areas require approval of the Regional Aviation Manager prior to use.

The touchdown pad shall be clear of all stumps, rocks, logs, or any item which may catch a skid, wheel, or spray boom. Where possible, do not disturb natural ground cover.

Dust abatement measures will be taken using acceptable methods as suggested by MEDC, Missoula.

Forest Service Manual

*-March 1976
R-9 Supplement No. 13
NA S&PF " " 2
NEFES " " 2
NCFES " " 2
FPL " " 5 -*

MIXING CHEMICALS

by

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I took a bit of latitude in the title "Mixing Chemicals" by expanding it to insecticide formulation and relating certain insecticide phenomena to the specific situation of forest insect control. I plan to discuss the formulation and properties of major groups of insecticides, their biological and environmental interactions and to mention some recent insecticide developments.

When produced and formulated by the manufacturer, insecticide preparations are more concentrated than those used for application, with few exceptions. Most working concentrations for field use contain 0.5% to 2% active ingredient. The major function of the formulation process is to provide a mixture that enables the pesticide applicator to reduce the concentration of active ingredient by diluting it with a suitable solvent, generally water or oil. Besides that, other desirable properties may be built into a formulation by including special additives. Formulation may be briefly defined, therefore, as any treatment of an insecticide to enhance its safety, its efficacy or its use characteristics. The most common formulations are emulsifiable concentrates (EC), oils, dusts, wettable powders and granules. Oils and EC's are most commonly used in forest sprays. EC's are diluted with water and oils with organic solvents such as fuel oil.

An array of concentrations of active ingredients, are available among the various formulations. Two conventions are used in stating concentrations on the title panel of pesticide containers. An emulsifiable concentrate containing 25% active ingredient would appear as "25 EC" or "25 E" on the front panel of a container label. Another system uses pounds per gallon: "4 EC" means 4 pounds per gallon, not 4% emulsifiable. By assuming that a formulated gallon weighs about 8 pounds, one can approximate the

concentration by mental arithmetic: 4 EC would contain about 50% active ingredient. Whatever the system, federal law requires a declaration of the actual percentage on the ingredients section of a container, generally a side panel of the label. There is never any doubt about the concentration of any formulation because of this regulation.

Let us turn briefly to the kinds of chemical insecticides that are used for pest control. Of the three major groups, the organochlorines (DDT, aldrin, lindane) were at one time the mainstay in forest operations and most other facets of insect pest control, but use of these chemicals is declining rapidly. For various reasons, most of them will be available only by special petition to regulatory agencies. The main features of organochlorines are chemical stability, low vapor pressure, water insolubility (ppm to ppb range), high fat solubility and relatively long biological half-lives. These chemicals are sufficiently durable to be translocated long distances from the application area. Methoxychlor is an organochlorine that epitomizes the "exception to the rule". Although closely related to DDT, it is not stable, fat soluble nor translocated by nondrift means to any great extent. Other organochlorines would be arranged between the extreme differences of DDT and methoxychlor. Hence, it is useful to generalize about chemical relatives but, if carried too far, would be misleading.

The other two groups of insecticides, the organophosphates and carbamates, may be discussed together as far as general properties are concerned. Chemicals in both groups were used when organochlorine use was widespread and their use is increasing as replacements for the latter chemicals. The organophosphates and carbamates may be described as chemical and environmental opposites of the organochlorines. They are not very stable in the environment, to the point that residue duration may be insufficient to be effective in certain situations or that repeat applications may be needed. The persistence of most organochlorines is measured in months, perhaps years in the soil. The environmental half-lives of organophosphates and carbamates may be measured in days. Sometimes they may last as long as 3 months in the soil but that is near maximum for them. Insecticides in both groups are metabolized quickly (biological half-lives are measured in hours to a few days), and they are not fat soluble. Consequently, they do not accumulate in organisms. Two properties vary so much among organophosphates and carbamates that it is not possible to generalize: water solubilities vary from a few ppm to 75% solubility (some will mix with water without additives); vapor pressures (volatility) vary from very low to sufficient volatility that certain organophosphates are useful as fumigants.

A couple of comments about insect exposure to these chemicals. That is, having sprayed a forest, if the insects are not sprayed directly, how do they contact these chemicals? There are three main routes of entry: one is tarsal contact, one is oral or ingestion, a third is respiratory. The first two are the most important as far as forest sprays are concerned. Almost all phosphates and carbamates are good contact poisons. Chemicals that are good contact poisons may kill insects in two ways: (1) during spray operations, droplets contact the insect's body, penetrating the cuticle; (2) after the leaf surface dries, the insect may pick up a dose of insecticide on its tarsi or feet as it crawls about the leaf. All good contact insecticides are also generally good stomach poisons, which means that insects may be killed by eating leaves that have been treated with insecticide. Fumigation is not a major factor in foliage applications.

Let us consider the surfaces that are sprayed, i.e., the primary target of a spray, the foliage or leaves. We should keep in mind that there are interactions of pesticides with those leaves, particularly with the waxy layer on the outer surface of the leaf. There are significant species differences with respect to the thickness, the chemical make-up and the physical form of that layer. All of these factors together will determine how the pesticides will act, how effective it will be and how long the residues will last on that species of tree. Knowledge of these factors help us understand why there are different effective residue times on different plants. The hairyness of leaves is a common example: the rough surface might tend to trap particles of a wettable powder, thereby preventing dislodgement during rain or heavy winds. Stomata (guard cells) may provide a route of entry for pesticides that evaporate on the micro layer of the leaf, to be transported into the cell sap directly. This may be more important for herbicides than for insecticides.

One matter that needs more emphasis is the plant waxes that cover the surface of the leaf. The waxes that are synthesized and extruded by the leaf are one of three different kinds of basic chemicals, either alkanes (or paraffins), long chain carboxylic acids or fairly long chain esters. Most of these compounds are solids and repel water. The composition of the wax layer is probably the most important factor of the interaction of the formulated pesticide with the leaf.

Most forest pest control specialists are familiar with Stokes' law, falling particles and the possibilities for drift of sprays. Besides drift, particle size is important in the efficient use of pesticides. Supposing you compared 4 pounds per acre at an

average particle size of 200 microns with the same quantity at 75 microns. The 75 microns spray will provide a better deposit and longer retention time. Besides the factor of drift, there are also certain requirements related to pest control that dictate droplet size.

Let me describe in general some of the events and interactions that occur when trees are sprayed in forest spray operations. Wetting and spreading is necessary for proper deposition of the pesticide on the leaf surface. Besides promoting a suspension in water for spray purposes, the EC formulation causes wetting and spreading of that pesticide on leaf waxes that may be water repellent. Water alone with bead up on an oak leaf without wetting the surface. Repeat that experiment with water and a surfactant (surface active agent) and you will see the drops tend to spread, almost coalesce, giving fairly even coverage over the leaf. The surfactants that are used may enchance the penetration of pesticide into the waxy layer of leaves. With contact insecticides, that is not always desirable because, while in the waxy layer, the insecticide is not available for tarsal pickup. Most research on the penetration of pesticides into foliage has been done with herbicides. It is desirable for herbicides to penetrate the waxy layer because it must be carried to other parts of the plant in order to be effective as systemic herbicides.

Having deposited an insecticide on the leaf and described its interaction with waxes, let us consider some of the other things that may happen to the chemical. Systemic insecticides are designed to penetrate foliage and be translocated throughout the plant. Surface residues of nonsystemics that evaporate may become attached to particulate matter suspended in the air. If the chemical is stable, it may be transported long distances in free or particulate form. For example, there was a recent dust fall in Columbus that originated from Kansas and Missouri. If that was agricultural land that had been treated with pesticides, analysis would probably show the presence of chemicals associated with agricultural spray programs from that area.

There are two processes that sometimes may be over-estimated in relating environmental contamination by pesticides to their uses. Keep in mind that, although there are wide variations, most organic pesticides are generally water insoluble. This contradicts the suggestion that much of the environmental contamination by pesticides is from leaching, i.e., the dissolving of pesticides in water, which is then carried as a true water solution into streams and other water systems. Leaching does occur, but probably it is not as significant in some situations as it has been estimated to be. The other process involves the transfer into streams by

erosion of pesticides attached to soil particles. In areas where there is sufficient ground cover to prevent erosion, such as forested land, there may not be significant transfer of that pesticide from the treated area into river and stream systems. On the other hand, evaporation should be given more consideration as a major process in the environmental translocation of stable chemicals and the dissipation of residues. Vapor pressures of $1x10^{-5}$ mm of mercury or less are common for many insecticides and such low values would suggest that pesticides are nonvolatile. Even so, significant evaporation rates of such insecticides have been measured in the laboratory and in the field. The presence of water (e.g., wet vs. dry soil) speeds the evaporation of practically all pesticides; likewise, high temperatures would facilitate volatilization. Most likely, evaporation is a major route of pesticide loss, particularly during warm and humid periods.

Let us turn to some of the chemical changes that can occur when pesticides are released into the environment. Atmospheric oxygen reacts with certain pesticides and these reactions are accelerated by light as well as heat. However, we must recognize that not all of these oxidation products are less toxic, even though most pesticide conversions result in reduced toxicity. Phosphates and carbamates are not very stable environmentally because they readily react with water in solution or in humid air. As the pH increases above 7, the carbamates and phosphates will increasingly degrade by hydrolysis. We are just beginning to understand the photo-conversion of pesticides. In this regard, sunlight, particularly the ultraviolet range of sunlight, is a potent factor in the chemical changes that occur in the environment. DDT, for example, interacts with sunlight in the UV range and is converted to products that are not toxic. Carbamates, organophosphates and other organochlorines will also react with light and be transformed. Dieldrin is converted to photodieldrin, aldrin in photoaldrin. Not all of these products are less toxic. Photodieldrin is more toxic than the parent compound.

Returning to the initial topic of formulation, I should summarize a few characteristics of the major ones. The term "oil" suggests that solvents such as fuel oil or other petroleum products were used to dissolve the insecticide. However, in pesticide technology, oil refers to a solution of pesticide in an organic solvent which may be further diluted with other solvents but is not to be mixed with water. Oil sprays will facilitate penetration of insecticide into insects that are sprayed directly but may also increase penetration into plant waxes. Oil sprays are relatively easy to formulate but volatility of the carrier may reduce droplet size during the fall period, contributing to drift. In addition, phytotoxicity may be encountered when organic solvents are sprayed

on plates. Emulsifiable concentrates may be thought of as oil concentrates containing a surfactant which yields an emulsion when mixed with water. Emulsions are oil-in-water suspensions of water insoluble insecticides, not true solutions. Because emulsions may break or separate, spray systems have recirculation and agitation mechanisms to maintain a homogeneous suspension. Water quality is an important component in the effective use of emulsified sprays. Hardness, or the presence of inorganic cations, may affect the stability of the emulsion or react with other ingredients in the spray. Most formulations now contain nonionic surfactants to avoid such cation-surfactant interactions. Alkaline water will cause decomposition or organophosphates and carbamates during transit and spraying.

Dry dusts clog equipment, drift excessively and deposit ineffectively, so they are not used as forest treatments or in other large scale programs. Wettable powders, which are essentially dry dusts plus a surfactant to effect suspension in water, are used frequently. Constant agitation is needed to prevent sedimentation after the formulation is added to water. Wettable powders may be the only available water miscible formulation when EC's are difficult to prepare. For example, carbamates such as carbaryl or Zectran^{R} are normally used as wettable powders. The particulate nature of wettable powders offers some advantages. Residue duration is generally longer in this form, evaporation is reduced, plant wax absorption is diminished and oral exposure is increased in those insects that groom or clean their tarsi by mouth, thereby facilitating ingestion.

Whatever the formulation, it may contain adjuvants or additives to attain special effects. Spreaders and stickers provide desirable residual properties; stabilizers increase the shelf life of concentrates or promote longer residual activity by maintaining safe pH values, trapping oxygen or UV light, or to retard evaporation. Some recent research on special effects deals with thickening agents to reduce drift and increase droplet deposition. Microencapsulation extends slightly the residual life of chemicals and reduces the mammalian dermal toxicity, a most beneficial feature.

Finally, I will finish with brief comments on recent developments of new chemicals or techniques. Although most of the following still requires more research, the potential use in forest insect control is obvious for most of them. One characteristic of most new chemicals is a relative narrow spectrum of biological activity compared to conventional chemical insecticides. Advantage has been taken of the physiological mechanisms that are unique to insects and arthropods in designing chemicals that specifically affect

those systems. Juvenile hormone analogues, commercially used to control mosquitoes, prevent adulthood and reproduction in those insects with a larval stage by mimicking natural hormones in the larva which maintain the immature stage. Anti-chitin compounds prevent metamorphosis by inhibiting the formation of chitin, an essential structural component of the exoskelton. Larvae treated with anti-chitin compounds die during the molt stage when the new cuticle is formed. Pheromones are non-toxic chemicals secreted by insects to provide behavioral cues among one or several closely related species. Researchers have studied and characterized pheromones for mating (sex attractants), aggregation, dispersion, alarm, etc. Pheromones have been successfully used to census populations of insect pest species by incorporating the attractant in an appropriate trap, such as that used by the Forest Service in their elm bark beetle research. Synthetic pyrethroids, chemical analogues of natural purethrins, are rapidly developing as a new, major class of insecticides, some of which are now registered for use.

However, each new group of chemicals provides a new set of problems to be solved if their full potential is to be realized in forest systems or elsewhere. For example, most juvenile hormone analogues are unstable, a benefit to the environment but often a disadvantage in pest control. Moreoever, they maintain the larval form, which in many cases would prolong the stage that causes defoliation or damage. We need field experience with all of these chemicals to learn their advantages and limitations, idiosyncracies and environmental behavior. The effects of chemicals on nontarget organisms should be monitored as new materials are developed for forest pest control.

MIXING AND APPLYING MICROBIALS

by

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This ia another one of Frank Lewis's annual or semi-annual get-up-and-talks about the microbials. And I, like Dr. Collins, am going to deviate a little bit from the topic of mixing the microbials and discuss some things about them, their formulations, and their peculiarities, all related to the mixing, applying, and effectiveness of these particular organisms. I'd like to make the point to start with that when most people talk about applying insecticidal material they mean the short-term effect; that is, applying the material in the spring and obtaining an immediate effect on the populations. In many cases pest controllers are not looking for, nor are they evaluating, the longer term effect of the treatment. The same happens with microbials. Most of the work up to now, as many of you know, has been toward utilizing these microbials as replacements for conventional insecticides. This is not necessarily the correct approach with these materials. In many cases it is like putting a square peg in a round hole.

I'll be talking primarily about the readily available microbials now used for control, that is, the nucleopolyhedrosis viruses and B.t. There are many other forms of microbials on the horizon but I don't think we need to go into those unless someone has questions about them later on.

Now, something about the physical characteristics of microbials. The microbials do not dissolve. They are particulate and, for the most part, they are stomach poisons. They must be ingested by the target insect to be able to exert their influence. Being

a stomach pesticide, the material must be applied to cover all the food surfaces. Poor coverage will not help the material work very well. My experience, as most of you know, has been mainly with the gypsy moth. This insect feeds on understory plants as well as canopy surfaces. So that means the material must reach and adhere to the leaves of understory foliage plants. It should reach the undersurface of the leaves as well as the upper surface. This is a formulation problem, a droplet size problem, and a penetration problem. You must be able to achieve full coverage to maximize the effects of microbials. This is where the quality of the application--where the pilot and his approach to the dissemination of the material--is critical.

Microbials are fairly ephemeral; they degrade rapidly in the environment, primarily because of temperature effects and certain parts of the ultraviolet spectrum. In many cases, they lose 70 to 80 percent of their activity within a very short period of time -- 1 to 3 days. Thus the number of applications must be sufficient to keep this material active against the insect long enough to allow ingestion of a lethal dose.

Humidity is also important in using and applying microbial insecticides. Humidity and humidity relationships may be even more important with newer microbial agents being researched now, such as the fungal agents.

In using microbial materials, the physical characteristics of the environment must be considered, but we also have to consider biological problems, since these materials are living entities, and they have unique biological characteristics which must be taken into consideration. They have modes of action that are different from conventional insecticides: they are slower acting, they must be ingested, they must infect or intoxicate the insect before an effect is noted. You may have to match the target pest insect with the pathogen. The polyhedrosis viruses act selectively on certain host species. For example, if you have a mixed infestation of defoliators and you are using a specific nucleopolyhedrosis virus (NPV), you will get an effect on certain species in that complex; it will not affect the entire complex feeding in that particular forest area. The wider spectrum microbial insecticide B.t. would have effects on many of the Lepidopterous defoliators.

Another biological characteristic that should be considered is the susceptibility of the host. With many conventional insecticides this is not the problem it is with the microbials. The stage of the insect is important; susceptibility is greater in young larvae.

Also the behavior of the insect is important as it relates to the feeding arena and thus to where the material is deposited. If the insect is a species that feeds at night, like the gypsy moth; and the microbial is applied early in the morning; the material, which you know degrades rapidly under UV, is in place for 10 hours or more under the influence of sunlight and is degraded before the insect even feeds on it. And then you expect it to work! It is important to consider the susceptibility of the insect, its behavior, the kind of material you are dealing with, and what peculiarities these materials have, in order to maximize the effect of the treatment.

The effects of different strains of these organisms must also be understood. B.t. has a very large number of different isolates that differ in their effectiveness on different pest species. The strain that is commercially available, for example, is not necessarily the most effective one for a given insect species. Similarly, certain geographical strains of the gypsy moth NPV are much more effective than others. These are some of the considerations that makes the use of microbials more complicated than the use of conventional insecticide materials.

There is one more important thing that I believe should be done. The microbial materials that are used need to be prechecked before you apply them. It is particularly important to precheck the complete formulation that you are going to use. Certain formulation materials may be put together for a certain field characteristic (rainfastness, UV inhibition, spreadability, density, resistance to evaporation, etc.) and for some reason or another the formulation doesn't work in the field. It is important to do a preliminary effectiveness screening in the laboratory before a mix is applied to large areas to check whether this particular formulation is going to do what you expect it to do in the field.

I'd like to discuss the use of diluents in microbial formulations. Dr. Collins mentioned water and water quality. I'd like to throw out some controversial thoughts here with regard to water and its use. Water has been and still is the diluent of choice with microbials. But how many times you have driven up to the nearest mud puddle, dropped a hose in it, mixed up your materials in a tank, loaded it into an airplane and applied it without making a single check on the quality of that water? The overriding consideration has been how convenient this particular body of water is to the mixing site. With microbials we need to be a little more careful. We need to know what, if any, contaminants are in this water.

What do we know about this water that we are diluting these materials with before we load our planes and apply it? We need to look at the pH of this water. This is critical with the microbials. If the pH is far from the neutral range, it could seriously affect the action of the materials. We need to know whether certain ions are present, since metal contaminants in the water can have deleterious effects on the enzyme activity of some of these microbials.

Additives used to formulate should be checked. We have tested a number of different additives from water to the commercially available virus adjuvants which are formulated specifically for application of the NPV's.

We use molasses (feed-grade quality) at the present time, in 25 percent concentration. Any less than 25 percent molasses does not give the best final formulation. We have had trouble with these additives in a number of ways, mostly with particulates, contamination that comes with them, and their environmental stability. I think we need to pay much more attention to this factor than we have in the past. Convenience is one thing, but safety and the total effect of the material are more important. We have also used #2 fuel oil with microbials. Oil has presented problems, primarily because it seems to have adverse effects on the feeding activity of the insect. Also, we have had suspendibility problems because wettable microbial powders are more difficult to keep in suspension in oil than in water-based formulations.

I'd like to turn to another part of formulation: the question of spreaders and stickers. Too many times we've heard about a good sticker, one that works well. We'll put it in the formulation because it really nails the material down on leaves.

I'll tell you a little story about a sticker we used some 10 to 12 years ago. We were early in the game with B.t., and were looking for stickers to keep it on the leaves so it wouldn't wash off. Tung oil was suggested as one of the best stickers available, and it is an excellent sticker. We used the tung oil as part of the formulation and it really nailed the material to the leaves. Then when the test was over and we began evaluating, we wondered why we weren't getting very good effects. The B.t. material looked good in the lab, but in the field it just didn't seem to work, so we backtracked and found that the tung oil was an excellent sticker--so good in fact that it coated the spore, it coated the crystal, and they zipped right through the insect untouched, undissolved, unsporulated, and without causing much mortality.

So it's important to look at these things in advance. A substance may be a good sticker, but is it good for this particular application? This should emphasize the point I made a little earlier; pre-treatment evaluation of formulations that you are planning to use in the field is absolutely necessary.

Now, a brief bit on the sequence of mixing: there is nothing magical about mixing microbials, any more than there is in mixing any insecticide material. How they are mixed depends in many cases on what kind of material you are dealing with. Here I will be talking principally about B.t. and NPV's. Emulsifiable concentrates, such as some of the Bacillus thuringiensis products, are usually used at full strength or partially diluted with water. It is relatively simple to mix and agitate these materials. Other B.t. products are available as wettable powders. The new NPV's, the gypsy moth NPV, the Tussock moth NPV, and Heliothis NPV are powders and present the usual problems of making a good homogeneous suspension. When we mix the gypsy moth NPV powder the sequence we follow is to pump water into the mixing tank to about half to two-thirds of the total volume of water for that particular mix. We then dissolve the UV screen in this water, add the molasses, then the sticker, and add the remaining water to complete the mix. The gypsy moth NPV is then added and the whole thoroughly mixed for 15 to 20 minutes.

This leads me to my final point about the sequence of mixing: many of the microbial insecticides that are available or on the horizon are not the kinds of materials you can mix last week, keep in the tank as long as you want, stir up once in a while, put in the plane, and apply.

They simply don't have that kind of stability once mixed. They can be mixed and held for a couple of days, but it would not be advisable to load that tank of mix into the plane and apply it. Our standard operating procedure with both B.t. and the NPV of the gypsy moth has been to put the active ingredient in the mix when we are sure we're going to apply it. Occasionally spraying is called off and you have to hold the mix, but fresh mixes are preferable and more active. This presents somewhat of a problem in large-scale operations, but we are dealing with materials that have certain peculiarities that must be considered.

Now a final point with regard to the safety of handling microbials. When people hear you are using a virus or a bacterium, they immediately shy away, merely because of the associations of the terminology. Proper communication and information usually alleviate this problem. These materials, as far as I know, are

not hazardous to man nor to beneficial forms of life. However, it's only sensible to take normal, reasonable precautions when mixing and handling these materials. One final point in mixing and applying microbials: make it a standard practice to clean out spray tanks, planes, and equipment every day. Microbial materials and the adjuvants can settle and plug mixing and application systems if they are not cleaned out thoroughly.

I trust that in this short time I have given you some idea of the problems of mixing and applying microbials.

METEOROLOGICAL CONSIDERATIONS

For Aerial Spray Application of Insecticides

by

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In this presentation we will cover three basic subjects:

1. Types of weather data that are available from the National Weather Service and how and where to obtain it.

2. Interpretation of weather data relative to forest spray operations.

3. How time-of-day, terrain and seasons influence wind behavior.

To explain the first two subjects, let's review operations of the National Weather Service at a state level. Most large states have a Weather Service Forecast Office and several Weather Service Offices. In Ohio the forecast office is in Cleveland and Weather Service offices are located in Toledo, Dayton, Cincinnati, Mansfield, Columbus, Canton-Akron Airport, and Youngstown.

Most Weather Service Forecast Offices have a staff of around 30 people including supervisors, forecasters, weather service specialists and technicians. Most of the forecasters in addition to their forecast responsibilities have a specialty. At Cleveland we have a Disaster Preparedness Meteorologist, a Marine Forecaster, an Ice Forecaster, and Air Pollution Program Leader, a Satellite Program Leader, and an Agricultural Program Leader.

At the Weather Service Forecast Office in Cleveland, a Lead Forecaster prepares zone and agricultural forecasts for the nine weather zones in Ohio. An Aviation Forecaster issues Aviation Terminals and route forecasts for within the state. Our Marine Forecaster prepares forecasts for Lake Erie and recreational boating forecasts for the near-shore area. In addition, our

forecasters must also prepare Air Stagnation Advisories, weather stories, a forecast for the city, and issue weather statements and warnings as required. The material for these forecasts are received on teletype and facsimile equipment; from satellite pictures; and from our local use computer programs which take into account the large scale, or synoptic, patterns in the atmosphere. The forecaster must review all of this material and decide which products are the best or at least the most applicable for his area.

Other activities at the Forecast Office include the taking of surface and radar observations, briefing pilots on flying weather, answer public requests for weather information, and making VHF-FM radio broadcasts. Weather Service Offices also do these tasks plus a few have to take upper air observations and all have to prepare a local and vicinity forecasts for their respective cities.

The main duty of all weather offices is to keep the public informed of approaching weather and to warn people of any hazardous weather that could present a danger to life or property.

As mentioned earlier the main forecast issued by the forecast office is the zone forecast. This forecast contains the expected sky condition, type and probability of precipitation, temperature and wind and the changes expected in these during the following 36 to 48 hours. At the Weather Service Offices the zone forecast is modified slightly to fit the respective metropolitan area. These forecasts are issued three times daily and amended or updated as needed.

Another type of forecast issued by the forecast office is the aviation forecast. These forecasts include the ceiling, cloud height, visibility and wind. They will also include the type and intensity of precipitation when forecast. Aviation forecasts are issued three times daily and are for the following 24-hour period.

A combination of the zone and aviation forecast will give a good indication of the overall weather expected. Other weather elements may be implied but not specified...such as the stability of the air, turbulence, and the amount of moisture in the lower levels of the atmosphere.

Another forecast available from some of the forecast offices is the agriculture forecast. The Cleveland Weather Service Forecast Office began issuing this type forecast on April 4, 1977. The agriculture forecast is given for each weather zone forecast at 430AM and 1030AM. Included in these forecasts are the expected rainfall amounts, percent of possible sunshine, relative humidity, dew points and the amount of dew expected overnight. This forecast would give you the expected sunshine and the moisture in the lower levels both of which are important to spray operations.

For spray operations the zone forecast which covers several counties would be useful mainly for planning purposes. It does not include the detail needed for an actual spray operation. Aviation forecasts can tell you whether conditions are such that the aerial spray plane or helicopter flight are possible. If the flying weather is suitable, the next decision is whether the spraying operation is feasible. The agriculture forecast provides some added information for this decision. For example, if the forecast calls for a morning with light winds, abundant sunshine and low relative humidity, it would indicate that there is probably high pressure over the area and a good chance of a successful operation during the early forenoon before any turbulence or any adverse local winds develop. In contrast, a cloudy day with light winds may be even better because it would indicate more stable conditions over the forecast area. Around sunset as the local valley or slope winds start to change direction could also be a favorable time.

There are other aviation forecasts issued by some Weather Service Forecast Offices which include a statement on turbulence which would indicate the stability of the air. These can be obtained from any Weather Service Office or from any FAA-Flight Service Station. All of the pilots present have made use of this service.

Weather stories issued by the various Weather Service Forecast Offices also contain information that could be of help in planning your operations a day or two in advance. These stories usually give the position and possible movement of weather systems for the next 24 to 36 hours.

Much forecast and weather information is available over the VHF-FM radio broadcasts or by telephone to one of the Weather Offices. We would recommend that after the preliminary planning is completed, you contact the local Weather Service Office for additional information you need or coordinate with the Fire Weather Forecaster for your area. The Fire Weather Forecaster for Ohio is located at the Weather Service Forecast Office in Louisville, Kentucky. He has the expertise to provide the final information needed for conducting the spray operation. He will, however, need time to assemble the needed information and to prepare a forecast, so please give him a few hours advance notice.

Since the local wind is a very critical factor in any Aerial Spray operation, a sound knowledge of the target area terrain and local wind patterns is required. Winds as given in zone forecasts are generally the pressure gradient wind and in summer sometimes include a thermal gradient effect. These winds are also the average wind for the period of the forecast. As such they are too broad a scale to base the final go-no-go decision on them

alone. For this reason, you need a forecast which considers all of the target area features that could affect the success of the spraying. You need to know whether there is an inversion and its approximate height, whether there is upward vertical motion or subsidence in the area and whether there is stable or turbulent flow over and in the forest canopy. Generally only a specialist would be able to provide all of these factors.

A question of great interest is how does time of day influence wind behavior? Since winds are strongly affected by local heating and cooling, there is a distinct change between night and day. Speeds are generally lighter and the turbulence is much less at night when the thermal gradient is weak. As the air heats it becomes lighter and rises due to bouyancy and gravitational forces. The colder heavier air moves in to replace it and this sets up a wind circulation. At night the heat gradient decreases as the ground cools. As the cooling continues the gradient may reverse with the coldest air at the surface and warmer air aloft (an inversion). The air warmed near the ground during the day rises and the light winds are replaced by stronger winds from above the friction layer, thus creating thermal turbulence. This effect is strongest during the early afternoon when surface heating is at a maximum and the air is unstable in the lower layers. The combined effect of the thermal turbulence and the transfer of momentum from aloft to the surface increases the average wind speed near the surface and decreases it aloft. This is the reason surface winds at most places are stronger in the afternoon than at night.

Another question often asked is how does terrain influence the wind. Only a very brief summary will be possible in the time left. Since terrain features in Ohio are more rolling than mountainous, the effect on the gradient wind is mostly in causing turbulence and eddies. In light to moderate flow there may even be no marked turbulence. If the flow is across the ridges the ridge top winds may be increased slightly especially if the air is stable. The wind may be channelled through passes or saddles and its speed there will also be increased due to convergence. In both of these instances eddies are set up on the lee sides. These eddies are evident at the surface as gusts superimposed on the general flow. If the terrain is mountainous the eddies will be much stronger and will form the well known lee waves or standing waves.

Another terrain effect is due to the differential heating and consequent convective wind patterns. These include the slope and valley winds; and the land and sea breezes.

Around the Greak Lakes there is the lake breeze and along the east coastal areas the sea breeze. When the pressure gradient is light and there is a strong contrast in temperatures between the land and water, the warmer lighter air over the land will rise and be

replaced by the colder heavier air from over the water. In this way the water to land circulation during the day is established. At night the effect is reversed since the land will cool faster than the water. The land breeze is usually weaker than the daytime sea or lake breeze.

Slope winds are local diurnal winds on sloping surfaces. The flow upslope during the day is a result of surface heating and the downslope at night is due to surface cooling. They are produced by the local pressure gradient caused by the differential in temperature between air near the slope and air at the same elevation away from the slope. As the sun hits the slope during the day the air is warmed near the ground and rises to be replaced by colder air from over the valley. These upslope winds are shallow but their depth increases from the lower slope to the top. At night the cooling of the surface causes a reversal with first a dying of the upslope wind, a relatively calm period and finally a gentle laminar flow downslope.

Valley winds are diurnal winds that flow upvalley by day and down-valley at night. The cause is the same as for the slope winds... differential heating between the air in the valley and air over the adjacent plain or larger valley. The upvalley wind does not start until the whole mass of air within the valley becomes warmed. Usually this is the middle or late forenoon. The transition from upvalley to down-valley flow takes place early in the night...depending on the size of the valley. These valley and slope winds are not independent...in the early morning the slope wind will be directly up the slope but as the valley wind becomes stronger during the day they cause the slope wind to be turned more upvalley.

Winds are usually stronger in the winter and spring than in the summer and fall. This is mainly because the storm systems are stronger and move faster in the colder seasons when the contrast between the extremely cold air from Canada or the Arctic and the milder air from the south is the greatest. In winter and early spring the prevailing wind is from the northwest while in the summer and early fall the prevailing direction is southwest. Of course these are only averages with winds from all directions during any season, depending on the position and movement of the storms through the area.

All of the discussion on wind variability has been very brief since time was short. For a very good description of winds and their variability and other weather elements in relation to Forestry see the Department of Agriculture Handbook 360 titled FIRE WEATHER.

SPRAY DEPOSIT ASSESSMENT

by

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INTRODUCTION

Spray deposit assessment plays an integral role in the evaluation of field tests, pilot projects, and operational projects of insecticides applied against forest insects. It is important in the determination of:

(1) Quality of Application - evenness of the spray, overall coverage and identification of areas missed by the spray.

(2) Spray Accountancy - where spray was deposited, both within and beyond the block.

(3) Biological Effectiveness - relationship of spray deposit to larval kill, host protection, and population reduction.

(4) Physical Spray Characteristics - drop density, drop spectrum, volume median diameter (VMD), and mass deposited.

(5) Physical Factors - influences of topography (i. e., ridges, steep slopes) and meteorological conditions.

FIELD ASSESSMENT METHODS

The procedures outlined below have been extracted from a "Field Manual for the Characterization of Spray from Small Aircraft" prepared under USDA contract by the USFS Missoula Equipment Development Center and FI&DM-MAG, Davis, California, (Dumbauld & Rafferty 1977).

Procedures for determining drop density, swath width and volume median diameter was designed to provide rapid in-the-field characterization of aerially applied spray.

These "quick look" procedures are intended to provide project personnel with information required to make immediate decisions regarding necessary changes in nozzle type, size, configuration, flow rate or other mechanical adjustments in the dissemination system to improve spray characteristics or to provide the optimum spray for the particular situation. These procedures are also intended for use in determining required changes in the aircraft flight altitude, location of the spray deposit card samplers and other parameters of the test plan to achieve better results.

Spray Deposit Cards

Spray deposit cards can be used for assessment in the field and the laboratory. There are several types of cards available:

(1) Sudan Black Cards - also known as the malathion card.

(2) Oil Sensitive Cards - used for oil or kerosene base sprays.

(3) Kromekote^{R} Cards - used with dyed or colored sprays. White Kromekote^{R} cards are the standard USFS sampler for spray deposit.

Field Estimation of Drops/cm^2

The Project Director is interested in obtaining the widest swath width in which droplet density equals or exceeds a specified drop density known or thought to produce the required efficacy. A "quick look" estimate of the minimum swath width and drop density within the swath width can be obtained by using the materials and procedures described below:

Materials Required	Use
Data sheets, clipboards, pencils	Recording drop number and data
Card Templates (clear plastic overlays with a grid of square centimeters)	Identification of card area for counting and sizing drops
Large, hand-held magnifier	Counting drops
Graph paper	Graphic data display

After the spray cloud has settled or dispersed, proceed on foot from one end of the exposed card line until spray deposition on the sampling cards becomes visible to the naked eye. Visually inspect the next few cards and note the position of the first card on which the drop density appears to be uniform. After inspecting this card to be certain that the stains have dried, estimate the spray drop density on this card using the following procedures in sequence:

(1) Remove the card from its holder and check card marking.

(2) Place the template over the card and fasten the card and template to the clipboard.

(3) Use a large hand-held magnifying glass to count the number of stains in the square centimeter area in the upper left hand corner. Record the number of stains in your field handbook.

(4) Continue to the next square moving down the extreme left column and add the number of stains to the number determined for the first square. If the total number of stains is 100 or less, continue to count the stains in subsequent squares until the total number of stains exceeds 100 for all squares counted.

(5) Enter the card number, total number of squares counted (area in square centimeters) and total number of stains on the data sheet (Figure 1).

(6) Divide the number of stains by the area (total cm^2 examined) and enter the drop density on the data sheet (Figure 1).

(7) Replace the card in its holder and return the cardholder to its original position for later pickup.

If the drop density on this card is less than the density needed to produce the required pesticide effectiveness, use the density just measured as a guide and walk along the card line to those cards which show greater densities and attempt visually to select a card showing the needed required density.

For example, if the first card shows a density of 10 drops/cm^2 and the required density is 20 drops/cm^2, proceed along the card line and select a card showing twice the density of the card just measured. Follow the same procedure for counting the stains to obtain drop density. If the measured drop density on the selected card is greater than or approximately equal to the required density, the edge of the swath can be obtained by linear interpolation. As soon as this edge of the swath is defined, walk to the other end of the card line and use the same procedures to define the other edge of the swath.

After determining the swath width, use the procedures outlined above for counting stains to estimate the drop density of the card near the swath center which appears to have the greatest density. Estimate the drop density on at least two other cards. If the drop density distribution is Gaussian (bell shaped), select a card half-way between the swath end and swath center on either side of the card showing the greatest density. If the distribution is slightly asymmetrical, which can occur when the aircraft does not fly directly into the wind, select the additional cards for analysis from the side of the distribution with the longest "tail". When the distribution appears highly asymmetrical, an additional trial must be conducted to estimate the minimum swath width. After the drop density estimates have been completed, note the location of the card marking the swath edges on the data sheet; determine the distance between these cards by multiplying the number of intervals by the distance of those intervals. Enter the swath width on Figure 1.

Field Estimation of VMD

The volume median diameter (VMD) is the drop diameter that divides the spray volume into two equal parts; 50% of the spray volume is in drop sizes below the VMD and 50% of the spray volume is in drop sizes above the VMD. This is a value commonly used to describe atomization of aerial sprays.

Prior to determination of VMD, the spread factor of the spray formulation must be determined. Since actual drop diameters are required for determination of atomization and quantity of spray, stains on the Kromekote cards are converted to actual drop size by means of a corrective spread factor. The spread factor is

the ratio of the diameter of the stain to the diameter of the aerodynamic drop causing it. Determination of a particular spread factor involves the production, collection and measurement of groups of uniform size droplets from which a calibration curve can be made.

The method for estimating VMD in this paper is based on inspection of sampling cards to determine the 5 largest diameter stains. The method requires selecting and measuring the largest stains, which usually occur near the center of the swath in an "in-wind" trial. Usually, these are the same cards which exhibit the highest drop densities.

The procedure for determining VMD is as follows:

(1) Select the sampling card near the center of the swath exhibiting the highest drop density.

(2) Visually select the largest stain appearing on the card.

(3) Measure that stain diameter to the nearest 50 micrometers using a magnifier graduated in 100 micrometer intervals.

(4) If there are several stains nearly as large as the largest stain on the card, measure and record their diameters.

(5) Enter the card number and stain diameter(s) on the data form shown in Figure 2.

(6) Proceed to the next card to the left (right) and repeat the measurement procedure.

(7) Continue measuring the largest stains on cards to the left (right) of the swath center until it becomes obvious that additional cards do not yield one of the five largest stains.

(8) Repeat the measurement process on the opposite side of the swath center.

(9) Using the spread factor obtained from the stain to drop curve (Figure 3) or the spread factor equation, compute the drop diameter for the largest stains on each card, and enter the results on the forms shown in Figure 2.

(10) Select the five largest drop diameters from the tabulated values and enter their card numbers and diameters in the spaces provided on the right-hand side of the form; enter the largest diameter at the top and the smallest diameter at the bottom. If two or more drops are the same size, they should still be counted as separate drops and listed sequentially in the "Five Largest Drops" table.

(11) The largest drop appearing in the "Five Largest Drops" table is used in the next step to estimate the VMD for the trial, providing that the difference in diameter between any two successively ordered drops does not exceed 32 micrometers. If a difference in diameter is greater than 32 micrometers between any of the drops, the drop just below the 32 micrometers gap is used in step 12.

(12) The VMD for the trial is estimated by dividing the drop selected in Step (11) by a factor of either 2.2 or 2.5 depending on the speed of the aircraft as noted in the form. Enter the VMD in the space provided.

As mentioned above, two formulas are shown on the form in Figure 2 for calculating VMD. If the aircraft speed during the trial was between 80 and 120 miles per hour, the largest drop diameter is divided by a conversion factor of 2.2. If the speed was greater than 120 miles per hour, the drop diameter is divided by 2.5.

As an example, assume that the aircraft speed was 90 miles per hour and the five largest drops measured on the cards in ascending order were 263, 280, 286, 321, and 355 micrometers. The VMD for the trial is calculated as follows:

$$\text{VMD} = \frac{286}{2.2} = 130 \text{ Micrometers}$$

Field Estimation of Mass Deposited

Procedures are described by Dumbauld and Rafferty (1977) and will not be discussed in this paper other than to point out that a method exists.

LABORATORY ASSESSMENT METHODS

Procedures are described by Barry et al., 1978.

Aluminum Plates

The use of aluminum collection plates is mainly restricted to research projects because of the extra effort and time consuming process involved in using them as samplers. They are used to measure the mass of insecticide formulation deposited and are assayed chemically.

Direct Examination of Foliage

Examination of foliage for stains of insecticide formulation can produce either qualitative or quantitative data. For qualitative data, the foliage is simply examined with a magnifier for the presence of stains. For quantitative data, the stains must be counted and sized. These methods can assess the adequacy of spray coverage. The only requirement is a suitable dye in the formulation.

Foliage Washing

The technique for analyzing spray deposit by washing foliage is similar to the procedures for analyzing deposit from aluminum plates. This deposit assessment technique has been used successfully for both coniferous and deciduous foliage. The procedure consists of removing a foliage sample from the tree immediately following spraying, washing the deposit from it, analyzing the wash solution fluorometrically, and then converting the results to express the deposit in terms of micrograms insecticide per unit of foliage (i.e., gram of needles).

Quantimet 720 Image Analyzer

The Quantimet^{R} 720 Image Analyzer is an essential part of spray deposit assessment methods for routine analysis of large numbers of samples. The U. S. Forest Service has been utilizing the Quantimet to assess spray deposit cards since 1974. This instrument rapidly counts and sizes stains on Kromekote cards automatically, whereas non-automated evaluation of the cards is tedious, time consuming and expensive process. When using the Quantimet for spray deposit assessments it is especially important to:

(1) Limit the size spectrum classes to 16 or less.

(2) Use an adequate concentration of dye.

(3) Carefully handle the spray deposit cards to avoid smudges and dirt.

(4) Identify each test card clearly and distinctly to prevent confusion and errors.

(5) Insure that the cards are kept dry.

There are certain inherent problems associated with the Quantimet. Since it cannot make judgments, it may detect dirt or other marks on the card along with the spray deposit. Stains that overlap are not distinguished as separate entities except by special time consuming processes. If there is insufficient amount of dye in the formulation, the contrast may not be detected by the Quantimet due to the limit of resolution, shading problems, or sensitivity of detection. The sampling area (the area of the card counted) decreases when the resolution is improved by changing to lenses of greater magnification.

However, the main problem encountered in card analysis is poor condition of the cards. Cards that are dirty, smeared, wrinkled or curled should not be evaluated by image analyzers.

ASCAS

ASCAS (Automatic Spot Counting and Sizing) is an automatic data processing program implemented by the USFS Forest Insect and Disease Management, Methods Application Group (MAG), at Davis, California (Young, et al., 1977).

This program analyzes the spot count data and computes the following diameters from the spray cloud:

(1) Volume median diameter.

(2) Mass mean diameter (diameter of a drop of average mass).

(3) Number mean diameter (Average number diameter).

(4) Number median diameter.

It also computes the deposition density in terms of:

(1) Milligrams/meter^2.

(2) Drops/centimeter^2.

(3) Fluid ounces/acre.

(4) U. S. gallons/acre.

A sample printout of the ASCAS program output is illustrated in Figure 4.

Basic steps to utilize ASCAS are as follows:

(1) Determine the specific gravity and spread factor of spray formulation.

(2) Collect spray deposit samples from field.

(3) Identify cards with appropriate spray block number, tree cluster, tree and position beneath the tree.

(4) Submit spray cards to appropriate lab to be processed by the Quantimet.

(5) Determine parameters needed for the Quantimet (drop size intervals and area of spray card to be counted) both of which are dictated by the lens.

(6) Process spray cards by the Quantimet.

(7) Obtain output data from Quantimet (either punch cards or magnetic tape).

(8) Process data cards or tape through the ASCAS computer program.

(9) Extract data from printout, analyze and integrate data into the reports.

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FIGURE 1

FIELD ESTIMATE OF SWATH WIDTH AND DROPLET DENSITIES

Date _____
Trial Number _____
Row/Line Number _____

Card Number	Area (cm^2)	No. of Stains	Density (Drops cm^2)
_____			
_____			
_____			
_____			
_____			
_____			
_____			
_____			

Card Number for Left Edge of Swath _____

Right Edge of Swath _____

Estimated Swath Width _____ Feet

FIGURE 2.

FIELD CHARACTERIZATION OF VOLUME MEDIAN DIAMETER (VMD)

Trial Number _____

Time/Date _____

Row/Line Number _____

Aircraft _____

Aircraft Altitude _____

Aircraft Speed _____

Spray Material _____

Flow Rate _____

Miscellaneous _____

_____

_____

Stain Factor Constants a _____

b _____

c _____

Stain Factor Relationship:

$DD = a + b\ (SD) + c\ (SD)^2$

DD = Drop Diameter

SD = Stain Diameter

Largest Stains and Drops

Card Number	Stain Diameter	Drop Diameter

Five Largest Drops

Card Number	Drop Diameter

$$VMD = \begin{cases} DD/2.2 \text{ (80-120 mph)} \\ DD/2.5 \text{ (} \quad 120 \text{ mph)} \end{cases}$$

VMD = _____

FIGURE 3. SPREAD FACTOR OF WATER AND 0.1% RHODAMINE B EXTRA S

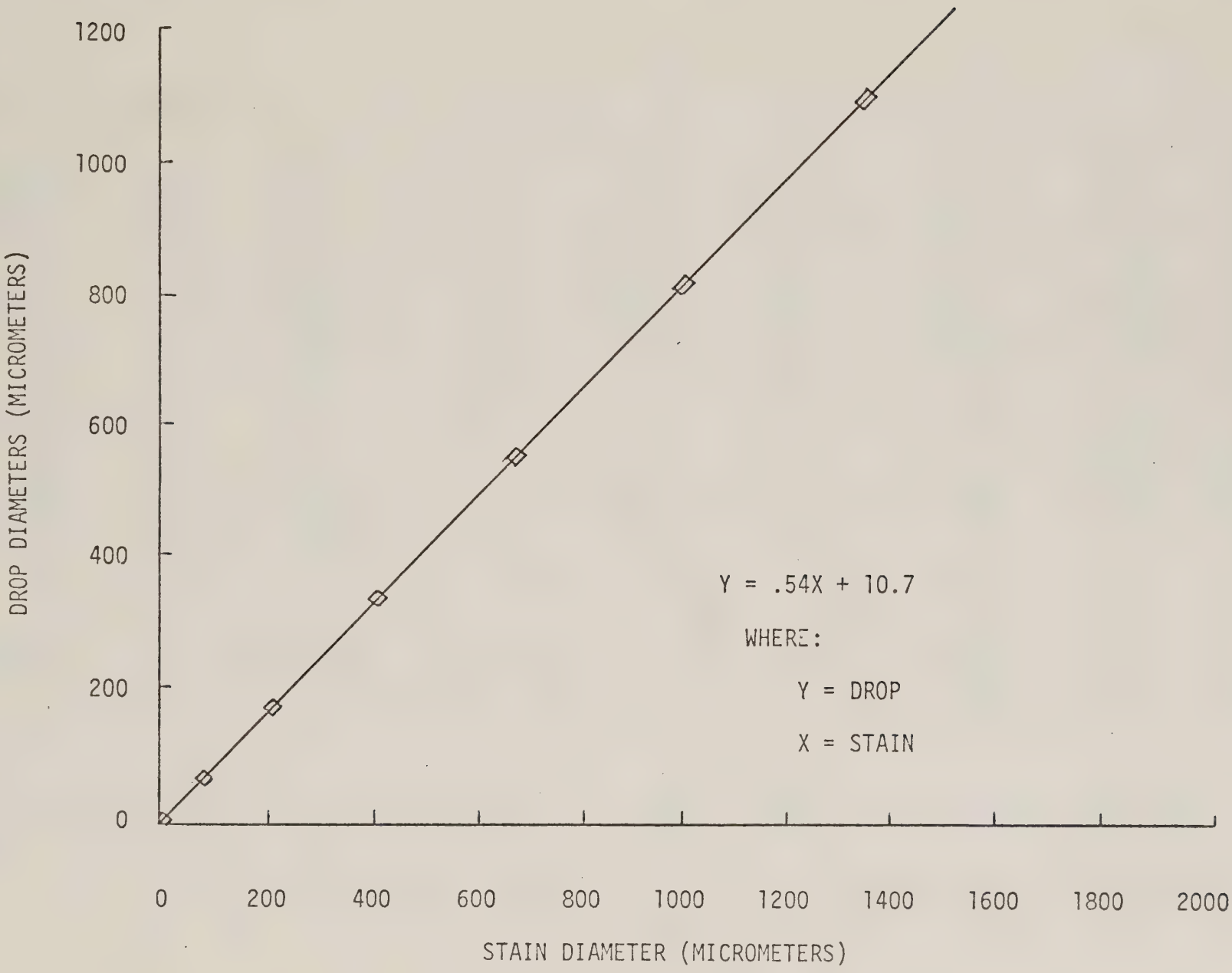

FIGURE 4. ASCAS PRINTOUT

Valid Cards Read In = 4

********** CONTROL CARDS **********

IFN = 1 IPRINT = 0 ISUMRY = 0 IDUP = 0 ISORT = 0 IORDER - 1 2 3 0 0
DENSITY OF MATERIAL = 1.011 G/ML PHOTO REDUCTION FACTOR = 1.000 AREA OF SCAN ON CARD = 8.8368 CM**2
DROP DIAM = (.6508E+01) + (.4760E+00)*STAIN DIAM + (0.) *STAIN DIAM**2

********** SIZE CATEGORY DATA **********

Size Category	Size Setting	Avg Size	Stain Of Up Limit	Stain Of Low Limit	Avg Stain	Drop Of Up Limit	Drop Of Low Limit	Avg Drop	Mass (GM)
1	95.0	54.8	95.0	0.0	54.8	51.7	6.5	32.6	1.837E-08
2	202.0	152.1	202.0	96.0	152.1	102.7	52.2	78.9	2.601E-07
3	300.0	253.1	300.0	203.0	253.1	149.3	103.1	127.0	1.083E-06
4	400.0	351.7	400.0	301.0	351.7	196.9	149.8	173.9	2.784E-06
5	498.0	450.4	498.0	401.0	450.4	243.6	197.4	220.9	5.705E-06
6	600.0	550.3	600.0	499.0	550.3	292.1	244.0	268.4	1.024E-05
7	704.0	653.2	704.0	601.0	653.2	341.6	292.6	317.4	1.693E-05
8	794.0	749.9	794.0	705.0	749.9	384.5	342.1	363.5	2.542E-05
9	901.0 <	848.6	901.0	795.0	848.6	435.4	384.9	410.4	3.660E-05
10	995.0	948.9	995.0	902.0	948.9	480.1	435.9	458.2	5.091E-05
11	1102.0	1049.4	1102.0	996.0	1049.4	531.1	480.6	506.0	6.860E-05
12	1200.0	1151.8	1200.0	1103.0	1151.8	577.7	531.5	554.8	9.039E-05
13	1299.0	1250.3	1299.0	1201.0	1250.3	624.8	578.2	601.7	1.153E-04
14	1573.0	1438.7	1573.0	1300.0	1438.7	755.3	625.3	691.3	1.749E-04
15	1775.0	1675.5	1775.0	1574.0	1675.5	851.4	755.7	804.0	2.752E-04
16	2511.0	2154.0	2511.0	1776.0	2154.0	1201.7	851.9	1031.8	5.815E-04

FERRIC CHLORIDE

FIGURE 4. ASCAS PRINTOUT (Cont.)

********** RAW DATA TABULATION **********

IDENTIFICATION					SIZE CATEGORIES															
1	2	3	0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	SUM
FECL3	0	2			37	13	21	14	1	1	9	2	2	0	1	1	0	0	0	1	103
FECL3	1	0			1	0	0	0	4	4	3	2	0	0	1	1	0	1	0	0	17
FECL3	1	0			11	11	18	15	11	6	0	3	1	2	1	0	2	0	0	0	81
FECL3	2				6	2	0	1	2	6	3	0	0	1	1	0	0	1	0	0	23

FERRIC CHLORIDE

IDENTIFICATION					DIAMETERS (MICROMETERS)				DEPOSITION DENSITY		RECOVERY RATE		AREA ASSIGNED	MASS RECOVERED
1	2	3	0	0	Mass Median	Mass Mean	Number Median	Number Mean	MG/M**2	DRP/CM**2	Oz/Acre	Gal/Acre	M**2	Grams
FECL3	0	2			871.3	272.1	106.5	139.0	1243.2	11.66	168.3	1.31	1.00	1.243
FECL3	1	0			539.6	381.4	286.5	318.9	565.0	1.92	76.5	0.60	1.00	0.565
FECL3	1	0			457.8	254.0	151.4	176.4	794.8	9.17	107.6	0.84	1.00	0.795
FECL3	2				504.9	325.9	248.1	225.5	476.9	2.60	64.6	0.50	1.00	0.477

FERRIC CHLORIDE

********** RESULTS OF ALL CARDS **********

	DIAMETERS (MICROMETERS)				DEPOSITION DENSITY		RECOVERY RATE		AREA ASSIGNED	MASS RECOVERED
	Mass Median	Mass Mean	Number Median	Number Mean	MG/M**2	DRP/CM**2	Oz/Acre	Gal/Acre	M**2	Grams
OVERALL	528.1	284.2	140.2	175.1	770.0	6.34	104.2	0.81	4.00	3.080

FIGURE 4. ASCAS PRINTOUT (Cont.)

********** TOTAL SUMMARY **********

Size Category	Number of Counts Over Spray Area	Mass Recovered Over Spray Area (GM)	Cumulative Mass (GM)	Percent Mass (=)	Cumulative Percent Mass (=)	Lower Limit Drop Size (Micrometers)
1	62240.	0.001	3.080	0.04	100.00	6.51
2	29422.	0.008	3.079	0.25	99.96	52.20
3	44134.	0.048	3.071	1.55	99.71	103.14
4	33949.	0.095	3.023	3.07	98.16	149.78
5	20369.	0.116	2.929	3.77	95.09	197.38
6	19238.	0.197	2.813	6.40	91.32	244.03
7	16974.	0.287	2.616	9.33	84.93	292.58
8	7921.	0.201	2.328	6.54	75.59	342.09
9	3395.	0.124	2.127	4.03	69.06	384.93
10	3395.	0.173	2.003	5.61	65.02	435.86
11	4527.	0.311	1.830	10.08	59.41	480.60
12	2263.	0.205	1.519	6.64	49.33	531.54
13	2263.	0.261	1.315	8.47	42.69	578.18
14	2263.	0.396	1.054	12.85	34.22	625.31
15	0.	0.000	0.658	0.00	21.36	755.73
16	1132.	0.658	0.658	21.36	21.36	851.88
TOTAL	253485.	3.080				

PESTICIDE SAFETY FOR AERIAL APPLICATORS

by

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From the beginning of time man has battled pests that compete for his food, fiber, shelter, health, and comfort of living. Only with the advent of chemical pesticides during and after the 1940's has man gained the upper hand in that battle. Yet even now, pests account for tremendous losses in agricultural commodities, environmental relationships, and health related to disease. Modern agricultural and environmental technology require sophisticated procedures of pest control. Pesticide use in conjunction with other aspects of agricultural technology has literally made North America the breadbasket of the world, providing an ample diet at a reasonable cost to U. S. families and also providing food exports to help feed the rest of the world. Thus we owe much to the science of pest control, but at the same time must exercise precautions to insure that such chemical tools do not become detrimental to the welfare of mankind.

In order to use pesticides safely, the applicator must understand some basic principles. A pesticide is defined as any substance used for controlling any organisms considered as pests to the particular environment in question. The name of the pesticide derives its name from the type of organisms to be controlled. The most common pesticides are insecticides, herbicides, and fungicides.

Chemical insecticide classes include the organochlorines (or chlorinated hydrocarbons), organophosphates, and carbamates which are all nerve poisons. The organophosphates and carbamates are cholinesterase inhibitors reacting against the enzyme in the blood stream that is designed to interrupt nerve stimuli and thus terminating a nerve movement. Lowering the cholinesterase level in the blood allows the nerve stimuli (acetylcholine enzyme) to

react unchecked and thus producing poisoning symptoms. Organochlorine pesticides react toward the central nervous system. But at present the exact mechanism is not known. Thus when one considers safety factors in the use of pesticides, he must protect that system in the body that would be affected. Likewise he must understand the toxicity of materials with which he works.

Organochlorine insecticides vary in the degree of toxicity and may be classified as persistent or non-persistent. Persistent chemicals such as DDT, Aldrin, and Chlordane may remain in the environment for several years, whereas, non-persistent ones usually degrade within the year and do not accumulate in animal tissue. Persistent chemicals generally pose less of a hazard from immediate acute toxicity, but some pose a greater hazard with long-term low level exposure.

Organophosphate insecticides generally are more hazardous to man but they are less persistent (from a few hours to a few weeks) and don't accumulate in animal tissue. They vary from those of extreme toxicity such as parathion to those of low toxicity such as malathion. Carbamates are similar to the organophosphates in toxicity, persistence, accumulation, and mode of action but they differ in structure and response to antidotes. Toxicity ranges from the highly toxic Temik to the slightly toxic Sevin.

Herbicides include a wide variety of chemicals such as phenoxy, carbamate, and triazine compounds. Herbicides may be very specific or non-specific in the species of plant they will control and some may be hazardous to animals. The different classes of herbicide compounds react differently in plant relationships, in duration of control, and in movement within the environment. Some adher very closely to soil particles and move only as the soil moves; others may vaporize to a certain extent and move with the air currents. Most herbicides are not water soluble and thus do not move with the ground water, etc.

Fungicides constitute a wide variety of structures, are generally less toxic to non-target organisms than insecticides and herbicides, and cause very few environmental problems.

Safety in the use of pesticide chemicals also requires using the proper type of formulation for the equipment employed and the area of application. Aerial application particularly must be concerned with drift of the spray, granule, or dust particles to places other than the target area. Pesticide formulations are designated by letter symbols for easy identification such as EC for emulsifiable concentrated solutions, WP for wettable powders, G for granules, SP for soluble powders, F for flowables, S for soluble liquids, etc. The proper selection of chemical and formulation for the job to be done is of vital importance.

Consequently make sure you read and understand the label each time you purchase the pesticide to make sure it is what is required for the particular application. Ingredients within formulation and the directions for use sometimes change even though the trade name may still be used. It cannot be over emphasized - Be sure you read and understand the label each and every time you use a pesticide.

As indicated earlier, the use of chemical pesticides does present potential hazard to men and the elements in the environment. As a means of reducing and/or controlling those hazards Congress passed a law in 1972 called FEPCA (Federal Environmental Pesticide Control Act) which amended the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for 1947. The law is now termed Amended FIFRA. The regulations imposed by EPA have been beneficial in some aspects but in many areas have caused confusion, difficulties, and unfound restrictions on pesticide manufacture and use. Amended FIFRA requires that all pesticide products in Inter- or Intra-state commerce be registered with EPA: that State laws on registration and regulation comply with Federal law and standards; that all pesticides registered or re-registered comply fully with up-dated conformance standards and be classified as to "restricted use" or "general use" products; that "restricted use" products be available to and applied only by or under the direct supervision of trained certified applicators. Standards of training and determination of competency of the applicator are defined in federal and state laws and certification plans, which in Ohio requires successfully completing a written examination. The law also specifies illegal acts in the use of pesticides which are punishable by fine and/or imprisonment for violation. Of particular importance to the applicator is the provision that pesticides must be applied only according to label instructions and any deviation whatsoever from what is actually written on the label is "Use inconsistent with the label" and thus illegal. (The reader is referred thus to the Amended FIFRA and the Ohio Pesticide Law for the details and implications of compliance.)

The first step in any safety program in the use of pesticides is "Understanding the Label". The label, by provision of law, should contain the information the applicator needs to properly handle and use the material. Consequently, we repeat again "Read and Study the Pesticide Label". Pesticides are identified by trade name, common name, and chemical name. There is only one common name for any one particular chemical compound, but there may be many trade names. Some people identify a pesticide only by trade name, but as indicated earlier, it is essential to verify that the product is the correct chemical for the job, etc. Thus, identification by common name is essential. Federal label laws require that the label identify the product, that it designate

what the material is (insecticide, herbicide, or whatever), and the net contents of the package be stated. Active ingredients must be identified and the percent in the formulation specified. The name and address of the manufacturer are required. All products must have an EPA registration number. The establishment number, also required, identifies the source of the material. The label must indicate the degree of toxicity of the product. Highly toxic pesticides (those in Category or Group I) are identified by the words DANGER-POISON printed in bold letters and generally red color. In addition, if the product is particularly hazardous to humans when taken internally or absorbed through the skin, the label must carry the skull and crossbones. Category or Group II pesticides (moderately toxic) require the label designation WARNING. Category or Group III and IV pesticides (slightly toxic and relatively non-toxic respectively) require the key word CAUTION. By law these words are to be used on the label only in the capacity of identifying the toxicity category of the product. They can not be used interchangeably on labels as may have been the case previously for any other purpose in the text of information. All labels, regardless of the toxicity category, are required to carry the words "Keep Out of Reach of Children".

Labels of toxic materials will contain a Note to the Physician indicating problems with and antidotes for poisoning and other important information for treating poisoning by the product. The label will describe the type of protective clothing and equipment required for safe use of the particular product, will indicate environmental concerns associated with the product use, and will list the physical hazards associated with handling and storage. As indicated earlier, the classification of the product as "General Use" or "Restricted Use" will be designated with instructions that "Restricted Use" products are for sale to and use only by certified applicators or persons under their direct supervision.

Directions for use of pesticide products are specific and a vital part of the label. Legal use of a pesticide product require that the pest and the host target must be written on the label along with the exact dosage and directions for use. The only deviation permitted from the label is if supplemental labels are attached as a result of the provisions resulting from an EPA PEPS (Pesticide Enforcement Policy Statement) or supplemental labels provided through authorized State Registration for Special Local needs and EPA Experimental Permits. Some information, although currently very insufficient, will be given relative to storage of the pesticide product and disposal of surplus pesticides and containers. When necessary, personal precautions in use of the material will be listed. It is vitally important to become thoroughly familiar with the label of the pesticide you are to use and read the label again prior to each incident of use.

When considering personal protection, the individual must consider all avenues by which detrimental contact with body systems may occur. Pesticides can enter the body by dermal exposure, oral ingestion, respiratory exposure, and via the eyes. Thus personal protection to the applicator must consider all these routes and the personal safety clothing and equipment must satisfy the particular circumstances of exposure. It is just as important to not over-dress for protection as it is to have adequate dress. Over-dress sometimes results in uncomfortableness with the results of shedding all protection.

The minimum protection to be considered in handling pesticides is generally full body coverage consisting of coveralls or cotton trousers and long sleeved shirt, etc. Selection of protective clothing depends to a large extent on the exposure potential. A pilot who may not have any contact with the concentrated pesticide formulation perhaps would consider a different degree of protection than the ground crew. Thus we need to consider both. The individual handling concentrated solutions of pesticide should be provided with a splash and water-resistant type clothing, preferrably a coverall and also consideration of an apron. Some materials are currently on the market of a "throw-away" type fabric that can be laundered when necessary but are economical enough to be discarded after heavy soiling or 2-4 times of use (depending upon the degree of contamination). Gloves should be unlined neoprene with a long gauntlet worn in such manner to prevent any run-off from the jacket sleeve or the glove itself from contacting skin areas. Cotton gloves are not satisfactory when working with pesticides and should thus not be used. Boots should be of unlined neoprene or natural rubber and worn inside the pant leg so that any spills or run-off will go outside the boot and not inside into the foot area. Recommended head covering is a hard hat or cap, equipped with a plastic headband, that will not absorb pesticides and that can be easily cleaned. Such hats also offer physical protection. Facial protection can be obtained by use of safety shields that can be attached to the hard hat or by eye shields and goggles. Top off the protection with a respiratory or gas mask suitable for pesticide work. The protective clothing and equipment worn by the pilot depends somewhat upon the situation and the condition of the cockpit. Generally the cockpit should be air tight and/or sealed against any pesticide entrance. Usual protection under those circumstances consists of a respirator, probably eye shield or goggles and a crash helmet. In cases where penetration of pesticide mists or vapors may enter the cockpit, respiratory protection may require complete head enclosure with a system having its own air supply and complete body coverage may be necessary. The pilot should avoid all circumstances (such as flying through drift or back through sprayed areas) that could cause contamination. Listings of satisfactory protective clothing and NIOSH or MESA approved respirator equipment should be available from your dealer or can be obtained from the Cooperative Extension Service.

Protective clothing and equipment are effective only if properly maintained. Consequently, it should be checked frequently. Pin holes in gloves can cause problems. Check protective clothing for tears, rips, broken seams, zippers that don't work, etc. Start each day with clean protective clothing and equipment. That means it should be laundered each day after use and should never be worn as regular street clothing. Even if it doesn't appear to be very soiled, pesticide protective clothing should not be worn from one day to the next without laundering. And to avoid cross contamination, do not launder pesticide clothing in the same batch as the family laundry. In most cases, the detergents and agents used in general laundering will degrade small amounts of residue that may be on the clothing.

Pesticide poisoning and accidents are generally caused by carelessness and inadequate knowledge on the part of the applicator or persons involved. It is thus important to employ safe practices and exercise care in the handling and application of pesticides. Personnel involved should recognize the symptoms of poisoning. Mild poisoning from organophosphates and carbamates generally is evidenced by symptoms of fatigue, headache, dizziness, blurred vision, excessive sweating, nausea and vomiting, stomach cramps, and diarrhea. Moderate poisoning includes symptoms of inability to walk, weakness, chest discomfort, muscular twitching, and constriction of pupils. Severe poisoning includes more pronounced evidence of the above symptoms with severe pupil constriction, muscular twitching, secretions from mucous and salivary glands, difficulty in breathing, and death if not quickly and properly treated. Symptoms of poisoning from other types of pesticides are similar in most respects but could include other effects. Thus the label should be consulted. Some of the symptoms listed above, particularly in mild poisoning, are also reflective of other health situations. Thus based upon the probabilities of pesticide exposure, the final diagnosis should be made by a qualified physician. Remember that pesticides can kill things other than the pests you are aiming at so you need to be aware of first aid and medical measures and obtain adequate medical aid in cases of human poisoning.

If a pesticide is spilled on an individual, remove the contaminated clothing immediately. If clothing is heavily contaminated, destroy it. Speed is essential because some pesticides can penetrate the skin in sufficient quantities within one minute to cause poisoning. Wash contaminated skin areas immediately with soap and water to remove all contact. If you breathe a pesticide, get to fresh air immediately. If it gets into the mouth or splashes into the eyes, flush the mouth and eyes with large amounts of clean water for 10-15 minutes and get medical attention. Don't eat or smoke while

applying pesticides and wash thoroughly afterwards before engaging in such activities. At the end of a pesticide application job, at the end of the day, or anytime contamination appears to be a problem, take a thorough bath or shower paying particular attention to the areas of the body such as hair, fingernails, etc., that sometimes washed only slightly and then dress with clothes that have no pesticide contamination.

Safe practices in pesticide use start with a proper diagnosis of the problem and subsequent selection of the chemical, again taking care to be thoroughly familiar with the label. Pesticides should be transported in an open vehicle; securely tied down to avoid rupturing and/or spilling; never with food, feed, fertilizer, nor human and animal passengers; and, if the situation requires other than an open vehicle, never in a completely closed vehicle nor on the seat of the car next to you; nor in situations where people or other commodities can become effected or contaminated. The greatest hazard involved with pesticides is when the applicator opens the can of concentrated category I or II pesticides and prepares the dilution for application. Thus great care and the wearing of proper clothing and equipment is vitally necessary. Carelessness can cause accidents. In aerial application, it is recommended that the pilot not be involved in any handling of the pesticide other than application. Exposure to the concentrated form of the pesticide may impair the senses (although perhaps not noticeable) to the extent that flying ability may be slightly dulled thus increasing the danger of a physical accident.

Make sure that the equipment is in a good state of maintenance; that hoses, seals, gaskets, pipes, etc., are tight and are not leaking in any manner. When equipment including nozzles need cleaning, use the proper techniques and never the mouth to blow out clogged apparatus. Make sure the system and each nozzle delivers the proper amount of solution.

Another aspect of pesticide safety, which we will cover only briefly at this time, involves storage. Whenever possible pesticides should be stored in a building separate from any other use. The building should be secure with limited access and preferably fireproof. Steel or cement buildings with cement floors generally offer satisfactory fireproof qualities. Storage areas should be equipped with an exhaust fan or some means of moving the air to prevent the building of toxic fumes and vapors. Personal protective clothing and equipment should never be stored with pesticides and if facilities require storage in the same building they should be separated from the pesticides by a fireproof wall.

All pesticide storage areas should be well designated in the languages of all people concerned at the particular operation indicating the hazard of the materials stored and the authorized entry. As an added precaution, a barrier fence around the storage area is suggested. Storage areas should be locked at all times with entry permitted only to authorized personnel and only the amount of pesticide to be used at that particular application removed. Never store pesticides with feed, fertilizer, equipment or other items. Always maintain good housekeeping by avoiding broken packages and leaking containers, spills, cross contamination, etc. Good housekeeping includes separation of different pesticides with labels readily viewable and the area kept clean. Spills, etc., should be cleaned up immediately. Storage should provide facilities for separation of insecticides and herbicides and even different chemicals within the same pesticide classification.

Keep pesticides in their original container and make sure the container is maintained in good physical condition. Our natural tendency to conserve space by transferring small amounts of pesticides to smaller containers, usually soft drink bottles or containers identified with some other use, is a major contributor to pesticide poisonings particularly with young children. If labels are lost from containers and consequently you don't know what the pesticide is nor how to use it, what should you do? Dispose of the material in an authorized manner. Don't take chances. Memories are not always as exact as written directions.

Another aspect of pesticide safety involves disposal. Because that subject will be covered by another speaker, we will not expand upon it at this time.

Proper use of pesticides can be a boon to the environment. Agriculture, forestry, and other related sciences depend upon the environment for their livelihood and thus we are not indiscriminately destroying such as some agencies would have the public believe. We are in reality the greatest environmentalists but it does require that we exercise care and precaution in avoiding operating conditions or situations that could result in contamination of soils, water sources, vegetation, etc., that could have a detrimental effect against domestic and wild animals, bird and fish life, desirable vegetation, and human populations. Remember you are a professional. Thus "Be a Pro" when using pesticides.

Additional references on pesticide safety that would be of value to the aerial applicator in agricultural and forestry operations are:

1. "Apply Pesticides Correctly. A Guide for the Aerial Applicator" EPA Manual for Pesticide Applicator Training.

2. "Apply Pesticides Correctly - A Guide for Commercial Applicators" EPA Core Manual for Pesticide Applicator Training (Can be used in conjunction with EPA slide sets developed for such training.)

3. "Aerial Application of Agricultural Chemicals" Agriculture Handbook No. 287 USDA, 1976.

4. Reprints from the World of Agricultural Aviation entitled "Principles and Problems of Aerial Pesticide Application" and "Controlling Drift of Herbicides". National Agricultural Aviation Association.

DISPOSAL OF INSECTICIDE CONTAINERS AND WASTE

By

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Today I will try to discuss disposal requirements in a general sense. We are involved at the state level with various types of ways, including pesticides, and ways of disposal. I don't profess to be up on the latest requirements in the Federal Register, and certainly not all the specific labeling requirements and all the requirements you might find on labels. Most of you who are working with larger projects have worked with U.S. EPA and you know what the disposal requirements for the specific pesticides you are working with.

Before starting any project, you should preplan for disposal of excess materials and containers. State and federal people should be contacted to determine the disposal capabilities of the area. You should check out the label of the materials ahead of time and make necessary arrangements if there are special requirements of disposal. The major rule to follow is to mix what you are going to use and use what you mix. The best way to get rid of excess is using it in a manner that it calls for on the label.

If you do get caught with pesticides that you have to dispose, first check the label for disposal information. If you don't have good disposal capabilities locally, check with the manufacturers. Many manufacturers will take back pesticides. Incineration is the best method if you are working with organics that do not contain mercury, lead, cadmium. Of course, you run into the problem there of locating properly designed incinerators with adequate air pollution scrubbing devices to get rid of larger quantities. Smaller quantities is often less of a problem. There are incinerators around the country that can handle most toxic and hazardous materials, including pesticides. Normally your state agency or U.S. EPA can inform you of what incinerators have the capability of handling the material you have.

In incineration isn't practical then you are involved in landfilling, and with landfilling these materials we have to be very careful. What we call landfills in Ohio may be quite different from what we call landfills in Kentucky, Illinois, California or elsewhere. In California for example, they have various categories of landfills, some of them licensed to take certain pesticides. In Ohio, we do not have landfills that are broken down in different categories based on the types of wastes they can take. However, for a landfill to take any toxic hazardous materials or other materials such as pesticides, they are required to have specific approval for these wastes as a part of the plan approval process. Very few Ohio landfills have this specific approval. More will have the approval in the future. We know a lot of pesticides go to unapproved landfills. Our agency has not been active in trying to run down every landfill operator that gets a couple of gallons of these wastes mixed in with his refuse. Just be careful of where it is going and make sure the site is approved to receive it. If you have a more persistent chemical or toxic chemical, the material should be encapsulated, and it should go to a secure landfill. In Ohio there are two sites considered secure landfills that are licensed for taking many hazardous wastes. Many states have landfills with capabilities of handling these wastes in the quantities that you are normally working with.

Where you are dealing with less toxic, less persistent chemicals, these can normally go into most properly operated sanitary landfills. I am talking of small quantities, not hundreds of gallons. Normally, if they go in mixed with solid waste, they will be broken down prior to ever moving out of the site. Of course, first check with the state agency that is involved in licensing the landfill, they can tell you whether the landfill is capable of handling your waste. We want to avoid these wastes going to landfills which are close to the ground water table where the chemicals could leach out into ground water supplies and contaminate them. If you don't have adequate disposal where you are working, store the material until you find out how you can get rid of it.

The other method is detoxification, chemical treatment. Some pesticides containing heavy metals which can't be incinerated in that form without having a lot of very specialized scrubbing equipment can have some of the metals precipitated out prior to incineration. Chemical treatment is also used to detoxify wastes prior to landfilling.

Let me know switch to containers. Combustible containers containing highly toxic and/or persistent chemicals should go to a pesticide incinerator where it's practical. If not, then they should go into a secure landfill. With combustible containers of lower

toxicity, and less persistent pesticides you may be able to burn them in open areas. Make sure you know what you are dealing with. I hate to make a very generalized statement like that but with some of the bags it may be the easiest and safest way to get rid of it. Know what you are doing before you do it.

For glass containers, in general, wrap them in paper and plastic and crush them before disposing of them. Metal containers should be rinsed and then punctured in a way which will facilitate drainage of any left-over rinse material as well as make sure somebody else doesn't use the container. Also, the rinse water should go back into the tank, not onto the ground. One of the real problems is poisoning from someone picking up a five gallon container or drum at a landfill that was punctured and using it for a bucket or for feed storage. Use your best judgement as to the type of landfill they should go to, depending upon the number and type of pesticide.

For drums, you should check with the manufacturer, often they will take these drums back, depending again on what was in them and the type of drum. If the manufacturer does not take them back make sure that they are properly punctured so they will not be re-used for something else.

If you're in a situation where you are storing some of these empty containers before hauling them to a landfill, take care that they are stored where kids cannot get into them. In taking containers to landfills make sure the operator does dispose of them. They should be mixed in with other refuse that comes into the landfill and be properly covered. Occasionally a landfill operator is known to pull stuff out for a little salvage operation on the side (normally without approval) and of course, he doesn't know what chemicals you are working with.

If you do have any in category one materials, and it's going to a landfill, make sure the landfill operator knows what you are giving him. Make sure he knows the hazard involved with material so he will not use it for something else.

There has been a fair amount of research in the last couple of years dealing with the disposal of pesticides. U.S. EPA has been involved in a number of projects. One of these of interest involved evaluating the use of municipal sewage sludge incinerators for incinerating pesticides. They found that many of the chlorinated hydrocarbons could be safely incinerated in these incinerators. The results of most of these studies can be found in the National Technical Information Service (NTIS) publication series available through the Department of Commerce.

At the University of Dayton they are doing a lot of work in incineration, looking at the temperature and burn time required for destruction. This work is geared to some of the more toxic material, especially some of the stuff being pulled off the market where they have larger quantities to get rid of. There have been problems in getting good incineration. A lot of work also is going on in microbial breakdown, and for many of the less persistent pesticides, some of this work looks real good. Some aeriation lagoons and biological treatment facilities are doing a very good job of breaking them down.

Also, related to this I should comment a little bit on RCRA, the Resource Conservation and Recovery Act of 1976, which the President signed in October of this past year, has some very important sections to it and it's going to effect what you are doing in the future. One of the things this does is it sets up a hazardous waste control program that is going to require the permitting of all hazardous waste storage, disposal, and treatment facilities. In most cases state agencies will be running this program. Where they aren't doing it, U. S. EPA will be running it.

The program will set up a manifest system as a means of tracking all hazardous waste materials from the generator to the disposal. If you are getting rid of any pesticides, once this becomes effective and in some states, such as California, its effective right now you will have additional paperwork. You will be signing off as the source or the generator, stating what the material is, who is handling or transporting it, and where it is supposed to be going for disposal. The transporter and the disposer have to sign off on the manifest. The regulatory agency will use this information to make sure these wastes go into proper treatment or disposal facilities. The federal regulations and guidelines are not out on this therefore I can't tell you what all this is going to involve at this point. Within the next few months we are going to see some of the first regulations on hazardous wastes and you should watch for them.

In summary, first preplan for disposal. Know what the disposal requirements are for the material you are using and the containers you will have. You can obtain information from the regional U.S. EPA office from your state agencies involved in solid waste disposal which is normally the State Health Department, State Department of Natural Resources, State Environmental Protection Agency, or you can get information from the manufacturer.

QUESTIONS AND ANSWERS

Question: You mentioned triple rinsing the containers and then you said to pour it back into the tank. Now to carry that a step further, when you are using another insecticide or herbicide in the tank, let's say the helicopter tank or the mixing tank of whatever, you've got to triple rinse that. How are you going to dispose of these three rinses--the volume of the three rinses? Are you going to fly over the area and give it a little extra dose?

Answer: Well, you want to know what is commonly done? Normally, it goes on the ground near the field or the area where you are working. It depends on the material. For many of the materials this is okay, it can be spread or buried in an area where it is not going to be disturbed. If you are talking about more persistent or more toxic material, then you must collect your wash water and properly dispose of it, especially if you are talking about class one pesticides. With class two you wouldn't be so concerned.

Well the problem here is it is very difficult to make a general statement as you well know. Acie, what do you tell farmers on this? I'd like to pass this one off to you.

Answer: Well, for one thing there is quite a bit of difference as Bill indicated this morning on what you have in the containers vs. the dilutent form you have in the tank. Now we normally tell them to spread it out over a large area of ground--either waste land or something of that nature where you would have less of a contamination problem. Or in the rinsing of spray tanks, the ideal thing would be to have an area in which you could take care of this with a collection basin in it where you could collect your rinse water. It's not really practical in an aerial application to rinse the tank out if you have to fly to let it out. So the best thing I could say here is to have in your filling area an area where you could collect the material as you rinsed the tank. Now the difference here too is that rinsing the tank of the dilutent material from the airplane is a little bit different from the concentrated material you are rinsing out of the original container. I don't know that anybody said to triple rinse a spray tank. Now you may have to put in some chlorine, bleach, ammonia, or something else to help clean out what might have been in there to begin with, but I don't know whether you have to go with the triple rinse. Of course, the triple rinse of the container means you are filling the container one-fourth to one-third full, and unless you have a pretty good sized tank, you are going to have a lot of material

to get rid of. But we generally tell the farmers to spread it over the land where it will not cause contamination, or to have a collection basin where they can rinse the tank and collect it where the water can evaporate then they can put lime or other stuff on the residue.

The important thing is if you do have very much of this wash solution and ordinarily we are applying it to the land like that to make sure it is not near any wells or in an area where animals are going to be active or near streams.

Question: I'm curious about other states that are represented here and what kind of landfill systems they have for land disposal, what the reaction by the landfill operators has been, are they able to dispose of the excess. I'm talking about say the 10-gallon cans and the disposal of pesticides in containers in landfills. Is there a state that has got a good system or is this lacking everywhere?

Answer: In California, we've got a pretty good system.

Answer: Well, I was just thinking of some commercial applicators in our area where we've used their airstrip and their facilities for some of our training sessions and they're disposal methods are horrible. There are cans just out lying around, I was just going to ask you what recourse does a public individual have if he feels pesticide containers aren't being disposed of properly. Do we have any recourse? Is there anything we can do?

Answer: Well, you know in Ohio the first line of control would be to contact the local Health Department, normally they have jurisdication over most activities like this. If it's a commercial application, the Department of Agriculture people who are licensing them should be contacted. Depending on how the states solid waste laws were written, they may be in violation on open dumping. And certainly with the new federal law we have now, Public Law 94-580, they would be in violation of open dumping and improper storage of hazardous materials, and there are some pretty stiff fines for that. In Ohio, it would probably be handled by our State Environmental Protection Agency. Our laws also provide for citizen's complaints which by law must be investigated.

Question: My reason for asking, making this first request was one kind of expected that response. It seems like we ought to forget about the landfill idea of disposal. I've got stuff I've had for five years I'd like to put in a landfill somewhere in Ohio and at this point there are not authorized landfills in Ohio to my knowledge unless you approach each landfill operator and ask him if he will accept it. It seems like we ought to go some other route than landfills.

Answer: For one thing, you can contact the manufacturer, most manufacturers will take back materials that have been banned. Another way is, U. S. EPA is required to provide a means of getting rid of it. I don't know how many people have ever done this, but you can get a form from them to fill out and ship it to EPA, and they will get rid of it for you. I don't know what all the requirements are to do this.

Question: I'll mail it to them. You acquire a lot of stuff, it's not just pesticides, it's also hoses, and old MC2 hoses used in fumigation, you must treat those just as you would treat a pesticide. So, I've got a lot of odds and ends, you know how state people do, if you have any idea how people's basements look, state facilities also accumulate stuff. Some of this stuff hasn't been used in forty years.

Answer: The best thing to do is contact our Office and we will tell you where you can get rid of it and work with the operator. I think in general that statement would be appropriate for most states. We only have a couple landfills that are licensed to handle most of this stuff but there are landfills around the state that can handle the majority of types of things you are referring to.

Question: I've made limited contact and have not been able to find one. I have not scoured the state but they are afraid of it, it's an unknown.

Answer: You are sitting next to a State Department man there from Agriculture and one of the bulletins we put out is our pesticide applicator information. On the back two sheets I've listed names and addresses of companies that specialized in pesticide disposal. Now Chemtrol is one company, they work out of Buffalo, New York, but their office in Ohio is in Canton. There is one place in Kentucky and one place in Indiana. They specialize in waste disposal that includes pesticide disposal. And on that list are barrel reclaimers and decontamination places, etc., and the main thing is most people don't know about this, I guess.

Question: The reason I asked about California is because you've got some desert out there and Oregon has a good kind of set up where they got waste land where they can set up decontamination areas in which the materials can be taken there and contaminates can be stored and disposed of on waste areas. That is why I was wondering if maybe Death Valley hadn't been used for some of this stuff.

Answer: The applicators, at least around Davis, the state comes in and certifies that the soil is suitable for waste disposal. There is one applicator that does a lot of business in our area, disposes of all his material left over in the aircraft by flushing the system right near the runway. We've asked him about it and he says the state has certified that site. I think that system is probably going to be on the way out because obviously a concentration soon builds up, but their containers they do clean, flush twice, I think the law states and supposedly they do that and they are taken to the landfill and disposed of.

Question: I think the biggest problem in this area is what to do with material left over in the aircraft and the flushing system and rinsing of these containers. In an area where you don't have the soil condition or even if you do, you will have a tremendous build-up. Then I guess what we are saying that nationally and state-wide, we are getting to better receive these chemicals.

Answer: Well, one thing mentioned right there, of course, extra material left in the tank when the plane comes back, plan on mixing up only what you need. There is another one that I didn't mention, Industrial Waste Disposal out of Dayton is another firm who has a landfill area to take quite a bit of this material.

Question: I attended a meeting about two years ago at Cornell where there was a fellow who spoke about an area, I don't know if it's the one you talked about in Buffalo or not, he called it the model city. Yes, that's the same one. That was really impressive the presentation he made based on that you have, you contact them and they not only dispose, they often reclaim products. If it's one they think they can make a profit on, they will pay you to take it off your hands. I think this may be the same one we talked about and its really impressive. The things they did with sludge and so forth. Material came in tank cars and trucks. It was really fantastic. I can tell you another incident, I don't know how legal it was but there was a place that had a lot of this stuff left over, they dumped into just enough radioactive material to get a reading off a GM-2 and took it out to the place where they bury waste from your reactors. You are putting material down these deep, deep holes that eventually is going to leak, I don't care what you say or how tightly you tie it up, eventually it is going to get out of there one of these days. I don't see anything any more hazardous than dumping a chemical down a hole like that.

I think we are going to see more places like Model City. The very persistent stuff that needs to be chemically detoxified, etc., are the main things going to these plants. There are a number of places throughout the country handling pesticide waste. This is probably the most complete plant and they serve all the northeastern part of the country. The thing is I don't think it has received the advertisement that it should within groups like this.

SPRAY BLOCK MARKING AND AIRCRAFT GUIDANCE

by

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Forest insect control is entering the age of professionalism. The public is demanding tighter control of aerial applications. Certification of applicators, even of project supervisors, is a reality. One of the prime responsibilities for the applicator is to ensure that the pest is controlled where it is intended, and insecticides are prevented from entering zones where they cannot be tolerated. Boundary marking for the pilots is a must.

The tree owner, or the forest manager, wants to get rid of a pest on a given piece of land. A project leader is appointed to get the job done. A field manager is assigned to plan and supervise the field work. Finally, the pilot arrives on the scene who interprets the sign language placed in the field and applies the pesticide. Hopefully, the pilot gets the jobs done to the satisfaction of everybody.

The Project Leaders job includes thorough direction of where the insecticide will be applied and where not. His emphasis and over-all knowledge will determine how well the job is performed. Delivery of spray to unwanted areas wastes the chemical, causes unnecessary environmental pollution, and may cause financial loss through law suits.

The Field Manager becomes a communication specialist when he guides the aircraft with sign language. During the planning phase, the type of guidance is considered. In this presentation I will consider ground marking only. For single pilot aircraft and for small blocks, ground marking is the only feasible method available.

During the planning stages, the Field Manager searches out all available maps and photographs of the spray areas. The latter are preferable if the tree types in the spray blocks tend to stand out from the surrounding area. During block layout, special emphasis should be placed on utilization of natural types and unique ground identifiers. Also, the boundary lines should be streamlined to fit the capabilities of the spray craft.

After the tentative block boundaries are determined, an aerial reconnaissance survey is helpful to decide on type and location of markers needed. One should keep in mind that the pilot will fly just barely over tree tops (50-100 ft) at 100 mph or faster. Experience in boundary marking is a valuable asset. Sometimes ground reconnaissance is necessary before the final location for markers is determined.

The last important job for the Field Manager is the preflight orientation. The pilot is provided with copies of the maps and explained what will be expected of him. Usually, the pilot will prefer an aerial examination of the spray blocks to get a visual imprint. It is important here that the pilot is given chances to evaluate the marking system and request changes to fit his capabilities. Remember - it is the pilot that has to follow that marker, not the Field Manager. As a rule, the pilots try to do the best job they can with the tools provided. Now, let's take a moment and review what the pilot is likely to do on the morning of spraying.

When the pilot arrives at the spray block, he makes a quick examination of the area to recall the visual imprint from the reconnaissance flight. An appraisal of the wind direction determines where he will start. As a rule, spraying starts on the downwind edge of the block. Also, the pilot prefers not to fly into the sun, because the ground and the workers are difficult to see.

Finally, the aircraft is lined up - the 2 points, the beginning and the end marker, are sighted in - and spraying begins. On longer runs, the pilot needs to keep the target marker in sight. After he finishes the first swath, the aircraft is turned around and the pilot must remember where he finished. On large projects, or where precision is necessary, markers are used to show each swath line.

After the first load of spray is delivered, the aircraft returns for reloading. Upon return to the spray area the pilot must remember where he left off - with experience he should be close. Any marking aids, or an observer plane can be of great help relocating that spot.

BOUNDARY MARKERS

A summary of various methods used for boundary marking is presented by Maksymiuk (1975)[1/]. The principal methods of marking are:

1. Ground markers, placed on roads, in forest opening, etc.

2. Markers placed on top of trees, from ground, or aircraft.

3. Above tree markers, such as balloons and lollipops.

4. Electronic guidance systems.

Which marking system is used will depend on cost, size of project and accuracy needed. My preference is helium filled balloons or similar devices. These can be raised to near the level of the flight, above trees, where the pilot can see them several miles ahead. The balloons (12" to 24" diameter) are generally available in novelty stores ($10-$20/gross). Use white, light blue, pine or light yellow colors. Helium tanks are available through most welding or gas suppliers. The large cylinders are heavy (100-150 lbs), but fill about 20 balloons. Smaller, back-pack size cylinders may be available through hospital suppliers. In thick, bushy forest, the filled balloons may be carried in plastic garbage bags, or filled at the corner from the small cylinder. The balloons should be suspended with at least 5 lb. test, light-weight,line. Monofillament, 5-20 lb. test, fishing lines are adequate.

The advantages of balloons are:

1. Low cost, if corners are accessible.

2. Can be set out quickly.

3. Visible from long distance.

1/ Bohdan Maksymiuk. 1975. Marking methods for improving aerial application of forest pesticides. USDA Forest Service Research Note PNW-262. 10 pp.

The major disadvantages are:

1. Must be set out shortly before spraying thus requiring many workers for a short time.

2. Require care in release, or the balloons may break in tree crowns.

3. Cannot be used on windy days - but, then we shouldn't spray anyway.

CONCLUSION

In summary, boundary marking is a method of communication between the Field Manager and the Pilot. The first signals messages, - markers, - showing where the spray block boundaries are. The latter interprets the message, and disperses the chemical. Experience and imagination is needed to accomplish the job.

ELECTRONIC GUIDANCE SYSTEMS

by

Samuel DeCamp

A copy of Mr. DeCamp's paper was not available for inclusion in the proceedings.

INFORM AND INVOLVE

by

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In the past foresters carried out professional duties without significant interference from the public. Today the public has an intense interest in what happens on forested lands. Most current Forest Management decisions will be weighed at the bar of public opinion.

The modern forester plans on involving the public before making most of his major land use decisions.

ITEMS TO CONSIDER

1. If you ask for public opinion be prepared to evaluate and use the input. You will have only one chance to develop the public's mutual trust and respect. If they see that their participation was not considered in the final decision they will not respond to future requests for public involvement. Remember your own agency is a public - keep them informed.

2. Your final decision document must include an analysis of the public involvement and how it was used in the final decision.

3. You may feel overwhelmed over the immensity of the job when you decide to initiate public involvement. Where do I start? Remember, since time began, 90 percent of the people were followers. Only 10 percent of the public are the "movers and shakers". Your job is to use every available means to contact and involve this 10 percent of the public and those that influence that 10 percent. The success of your project will depend on the acceptance of your decision by this key group.

4. Adoption of an idea or proposal is a series of steps which occur in a definite sequence. The further along the chain of acceptance the group or individual is, the more difficult it becomes to change the group's or person's way of thinking or acting.

STAGES TOWARD ACCEPTANCE OR CHANGE OF AN IDEA OR PROPOSAL

A. Awareness

Prior to this time the public does not know or care that the proposal existed. Their attention must be gained.

The best method of obtaining the public's attention is through use of the mass media, i.e., news releases, radio, television interviews, and television news coverage of the situation. Presentations to key groups or organizations is also very effective at this point in the involvement process.

B. Interest

The people have now become interested enough to want to know more about the proposal.

At this time you should have a concise, professionally prepared brochure that can be provided to the public when interest is expressed. At this stage of the involvement process a series of public listening sessions should be initiated.

Public Meeting Guidelines

1. The meeting dates and locations should be well publicized.

2. The meeting sites should be selected to permit convenient access for the people who will attend.

3. The meetings should not always be scheduled during a week day. Plan the meetings in the evenings or on non-work days. This will permit attendance without interfering with working hours.

4. A local respected group should sponsor the meeting. This will provide creditability to your organization. They may have a meeting place.

   A leader of this group should facilitate your program.

Conduct of the Public Meeting

The overall objective is to equalize the big state or federal organization with the individual citizens. This will permit exchange of ideas to take place.

1. A neutral responsible person should moderate the meeting.

2. Responsible line officers should be present, but not conducting the meeting.

3. Taping can be useful; but if done make it obvious and tell the audience. Don't limit note taking to tape.

4. The ground rules for running the meeting should be reviewed with the group, and any suggestions incorporated.

5. Do not use a platform to talk down to your audience. All facilities should be at the same level. This is an equal give and take session.

Meeting Format

1. Introduction by sponsoring group.

2. A short well-prepared slide program giving an overview of the problem and possible solutions. This should not be an "ego trip" for your specialists. It should be no longer than 20 minutes. Remember this is a listening session. You want to save most of the available time for obtaining citizen views and opinions.

3. A suggested procedure for obtaining and recording input is as follows:

    a. The meeting facilitator recognizes those wishing to speak.

    b. The meeting ground rules provide that each speaker states his name and his organization affiliation.

    c. Following the statement the facilitator verbally summarizes the statement to make certain the speaker is satisfied that he has been heard.

    d. A recorder writes a summary of the statement on newsprint, including the individuals name and organization affiliation.

e. These newsprint sheets are posted on the wall. The people making the statement know the "system" has heard them.

f. Continue the meeting until all persons have had the opportunity to be heard.

g. At the conclusion of the meeting, after all the statements have been made, the facilitator will state, "What we heard tonight is posted on the charts. If any input is incorrect, please feel free to make any necessary changes." All input is now visible and the speaker has had the opportunity to make any necessary corrections.

h. Do not expect to obtain technical input at these meetings. You will receive mostly expressions of feelings and emotions. This is very valid input since many major issues in the political arena are settled on this basis.

C. Attitude

After interest has been generated the public develops an attitude. The people who decide to become involved will begin to contact your office. This contact will be in person or by letter. Make sufficient time available to give any necessary information. Make certain these people are satisfied. They will make or break your effort.

D. Opinions

Opinions are stronger than attitudes and result from attitude evaluations. There is still some doubt, but one side of the controversy definitely has been taken. Consent is often given at this point to try the idea on a small scale. Experience indicates that the best motivational method to use after opinions are formed is through personal contact by friends and neighbors.

E. Beliefs

This is the last stage in the involvement sequence. The idea has been accepted or rejected. A public has a great tendency to want to preserve its beliefs.

Evaluation of Public Input

All input received must be documented. This input must be fully analyzed, and arrayed for use by decision makers. Public involvement is not rule by majority. The public has expressed its feelings and opinions, and has provided additional data to the proposal. The decision maker should review this input, along with the other data, prior to making his final decision. When this decision is reached it will consider, maybe for the first time, the feelings, opinions, and additional data provided by the public. The final decision may not be in harmony with the public input, but at least the decision maker knows this prior to making the decision. The public may not like the final decision, but at least they will know they had the opportunity to be heard.

COORDINATION AND COMMUNICATION OF AERIAL SPRAYING IN PENNSYLVANIA

by

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INTRODUCTION

Instead of going into a theoretical discourse on coordination and communication, I would like to tell you about the aerial spray projects in Pennsylvania. During this discussion it will become very evident that good coordination and communication are a real necessity in both the planning and the application of an aerial spray program.

Pennsylvania is presently bearing the brunt of the gypsy moth damage in the nation. This year the extent of defoliated woodland in the state is expected to exceed one million acres. Although our Bureau has been involved in the spraying of several forest insects, most of my experience has been with the gypsy moth; and my presentation will refer primarily to this insect, although the principals can be applied to any destructive forest insect. Some of the neighboring states, which are in line to get the gypsy moth, may get some indication of what they can expect in the future.

PREPARATION

Before a program can get started even in the planning stage, there must be a good understanding of the objective. In Pennsylvania we are not engaged in an eradication program. The gypsy moth is far beyond the stage of possible eradication with the tools and

funds that are presently available. Instead, we must learn to live with this insect. The spray program is designed to provide foliage protection and population reduction at the times and in the places where it is economically justifiable to suppress the insect. These places are residential and recreational, where people come in direct contact with infested woodlands. In the past some untreated camps were forced to close for most of the summer because of the caterpillar nuisance.

Although the actual spraying may take only five to seven weeks, the planning for a large program develops into a year-round job. As soon as one program ends, the planning for another program begins. Sometimes they overlap, so it is very difficult to see the separation. Let's briefly go over the chronological development of a spray program.

PROGRAM DEVELOPMENT

The gypsy moth suppression project in Pennsylvania is a cooperative program with responsibilities and financial input coming from county, state and federal governments. The interaction of these agencies is primarily of a straight line fashion. This puts the state in the middle of a two-way communication link.

Perhaps the best place to break in to this yearly chain of events would be at the time of defoliation. Peak defoliation occurs in late June or early July. All of the state is flown by state personnel, and the defoliated areas are plotted on maps. This is followed by ground-checking and acreage calculations. This information is compiled and additional maps made on various scales. All of the affected counties are then informed of the situation in their area.

It is the county's responsibility to determine if they want to participate in a suppression program. If they do wish to become involved, they must work up a proposal by October of the private- and county-owned land that they would like to see treated. The proposals for state-owned land are compiled by district foresters, state park officials, state Game Commission officials and Department of Transportation personnel.

During the next three months the state sends its field crews out to make a biological evaluation of each proposed treatment area. This assures uniformity and compliance with guideline regulations.

By January the initial field checks are completed, and the information goes into the federal government for the compiling of the Environmental Impact Statement. The chemical company representatives are contacted concerning quantity of materials needed and possible delivery dates. The spray contract is written and checked by various state personnel before being sent out to all interested aerial applicators.

In February finishing touches are put on proposed spray maps. The counties are notified of the accepted areas, and they start work on a mailing list for resident notification. Other interested state and federal agencies are contacted, and careful checks are made with other spray programs and research groups to be sure of no duplication of effort in the same area.

In March we have the bid opening. A meeting is arranged with the successful bidder to go over all the fine details. If possible, an inspection trip is arranged to check out the equipment to be used on the contract.

During the actual application phase of the program all the days of advanced planning pay off. Coordination and communication become critical, and accurate timing is essential. A large number of people become involved in forming marking crews and supervising areas of the project. This year we expect to treat 358 separate spray blocks making a total of 76,500 acres spread across 18 counties and involving 8 forest districts. We expect a total of 135 people to be involved in the program over the course of the project. About one-half or less of these people will be working at any one time.

Good two-way radio communication makes it possible to keep track of all the marking crews and coordinate their movements with the contractor. At times a radio is supplied to the pilot and he can then be contacted by ground crews as well as an aerial observer when it is needed.

Accurate maps, good orientation sessions and reconnaissance flights, along with a large supply of accurately located bright colored helium-filled balloons, assure treatment of the proper area. Periodic checks of the chemical delivery system are necessary to assure uniform application.

Keep good records and don't rely on your memory for exact details. Hold debriefing sessions with the pilots and make special notes about problems so they can be reviewed and possible solutions developed before the next program gets underway.

If at all possible, revisit the treated areas both on the ground and from the air a few weeks after treatment to evaluate the effectiveness of the program.

CONCLUSION

In an aerial application program a great number of people must work together, and the operation must be done properly within a rigid time frame to produce a successful program. It is a chain of events, each linked to the next and each one influences the final result. Coordination and communication are the cement which hold the pieces of this puzzle together. It is only through the intelligent use of these two forms of interaction that cooperation can be developed, and cooperation is really the name of the game in Cooperative Forest Pest Management.

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